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ABSTRACT

Presented is the second volume of a three-volume report detailing the evaluation of the National Science Foundation Comprehensive Assistance to Undergraduate Science Education (CAUSE) program, a program developed to encourage the improvement in quality and effectiveness of undergraduate science education in institutions of higher education. This volume contains 25 case study and visit reports that were conducted over a period of a year and involving several visits to each project. Chapter One is an analysis of findings from visits to 25 CAUSE projects. Eight case studies are detailed in Chapter Two, which provides an in-depth look at a select group of projects. The 17 site visit reports of Chapter Three represent evidence gathered from one-time only visits to chosen institutions and are meant to provide a medium-range view of some projects. (CS)

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AN EVALUATION OF THE NATIONAL SCIENCE FOUNDATION COMPREHENSIVE ASSISTANCE TO UNDERGRADUATE SCIENCE EDUCATION PROGRAM

Jane G. Cashell and John D. Eggert
Project Co-Directors

VOLUME II:
VISITS TO TWENTY-FIVE CAUSE PROJECTS

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DEVELOPMENT & EVALUATION ASSOCIATES, INC.
4836 Westfield Drive, Manlius, New York 13104

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PERSONNEL ROSTER

An Evaluation of the CAUSE Program

Evaluators and Report Authors - Development & Evaluation Associates, Inc.

Jane G. Cashell, Project Co-Director
John D. Eggert, Project Co-Director
Richard M. Lent, Research Associate
Terry Coleman, Research Associate
Kathleen Porter, Research Associate
Jody Karen Witham, Research Assistant

Project Staff

Marti Haggerty, Business Manager
Betty Kuttruff, Secretary
Jan Sernett, Administrative Assistant
Susan Koprowski, Project Secretary

Science Consultants

Thomas Allen, Professor of Chemistry
Hudson Valley Community College
Jacquelyn L. Beyer, Professor of Geography and Environmental Studies
University of Colorado at Colorado Springs
David P. Butts, Professor of Science Education
University of Georgia
Esther Lee Davenport, Research Engineer
Georgia Institute of Technology
Marvin Druger, Professor of Biology
Syracuse University
James J. Gallagher, Director, Science and Mathematics Teaching Center
Michigan State University
Ramesh Gaonkar, Professor of Electrical Technology
Onondaga Community College
John E. Penick, Associate Professor of Science Education
University of Iowa
Spencer Swinton, Research Psychologist
Educational Testing Service
Robert E. Yager, Professor of Science Education
University of Iowa

Cost Analysis Consultants

Albert Beilby, Assistant to the Director, Office of Library Services,
Central Administration, State University of New York
Philip L. Doughty, Associate Professor of Instructional Design,
Development & Evaluation, Syracuse University
Peter A. Stace, Assistant Dean, College of Arts and Sciences
Syracuse University

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PREFACE

This document is Volume II of a three-volume evaluation report on the National Science Foundation Comprehensive Assistance to Science Education (CAUSE) program. A primary challenge in evaluating the CAUSE program is the great diversity of projects. Each project differs greatly from the next. The students, faculty, mission and location of each institution makes each project unique. In order to adequately describe the CAUSE program we chose data collection techniques at three levels of focus: 1) A broad focus which includes an analysis of funded proposals and a survey of all project directors; 2) a medium focus which consists of one-time only site visits to 17 CAUSE projects; and 3) a narrow focus which consists of in-depth case studies of eight CAUSE projects. This volume contains the 25 case study and site visit reports. Descriptions and analyses of the broad focus studies can be found in Volume III. The overview and findings of the evaluation as a whole are in Volume I.

The case studies were conducted over the period of a year and required several visits to a project. Site visit reports are based on a single two-day visit to a project. These techniques were chosen as a way to convey to others what projects look like in operation. The reports go beyond the information regularly provided by projects in their proposals, interim and final reports. The advantage of the reports or the visits to 25 porject is that they focus on the characteristics and special situations of 25 different projects. The reader will be able to get a sense of the diversity of CAUSE projects as well as an in-depth understanding of how some porjects work. The disadvantage is that it is all too easy to generalize from the specifics of the case of one porject to the CAUSE program as a whole.

The reader will find these reports rich in the detail of a CAUSE project, its staff and its institution. The reports are provided in full in order that the reader can experience some of our data gathering activities secondhand. Probably few readers will attempt to read all 25 reports. However, we strongly encourage every reader of Volume I, the overview and findings from this evaluation, to delve into at least one case study and one site visit report. If time permits, more reports should be read as they are an integral part of the overall evaluation report. They will provide a deeper and more complete understanding of specific CAUSE projects, the CAUSE program, and the evaluation of the CAUSE program.

INTRODUCTION TO VOLUME II

Overview of the Volume

This volume is divided into three chapters. The first chapter summarizes observations made from visits to 25 projects. Chapter Two contains eight case study reports and Chapter Three presents 17 site visit reports.

Chapter One is an analysis of findings from visits to 25 CAUSE projects. The analysis and discussion in this chapter are organized around the six issues which focus the whole evaluation. The issues are: 1) the extent to which high priority local college and university needs are being met by local CAUSE projects; 2) the ways in which CAUSE projects are being implemented; 3) the extent to which instructional improvement is resulting from CAUSE; 4) the nature and use of evaluation data on CAUSE projects; 5) the relative costs of the functional activities of CAUSE projects and how they relate to post-CAUSE institutional support; and 6) program changes and modifications to be made in the CAUSE program.

While the reader may be inclined to view Chapter One of this volume as a summary of the 25 reports on projects, we believe that this chapter in no way replaces the impact of the information presented in the individual case study and site visit reports. Therefore, we simply urge the reader to read a number of reports in addition to the analysis of findings from the visits to projects found in Chapter I.

Chapter Two contains eight case studies which were designed to provide an in-depth look at a select group of projects. The case study reports are based upon repeated visits to a project by an evaluator, a scientist, and a cost analyst over the course of a year. Returning to projects again and again over time had several advantages which included the possibility of observing the process of change, the development of a deeper understanding of an institution and its people, and the chance to observe unexpected events and outcomes.

The 17 site visit reports in Chapter Three represent evidence gathered from one-time-only visits to the chosen institutions. They are meant to provide a medium range view of some projects. Each of the 17 sites was visited by an evaluation specialist from DEA and a science educator. These visits lasted two days and consisted of interviews, observation, materials review, and project document review. All of the issues of the evaluation were attended to except cost because we believe that cost issues are best examined in the context of a fuller and more in-depth investigation.

To help the reader identify the individual reports that might be of greatest interest, a brief review of how the projects were selected and the nature of the projects themselves is in order. The case study and site visit projects were chosen with the intent of getting as representative a sample as possible along such variables as institution type, duration of project and amount of funding. The institutions visited represent a range of different kinds of projects being implemented in different settings with their unique sets of problems and opportunities. The names used for these institutions and their locations in the following reports as well as the names of project directors, faculty, and administrators at those institutions are fictitious. We have avoided using real names in order to protect the anonymity of people who have given us such a high level of cooperation and help in the process of carrying out our site visits and case studies.

Within their respective chapters, the eight case studies and 17 site visit reports are arranged alphabetically according to their fictitious names. As a guide to these reports, selected characteristics of each institution and project are outlined below.

Summary of Projects Visited

Case Studies

Cedar State University.

Description: One of the two major public universities in a midwestern corn belt state

Project Focus: The Redesign of 3 Courses and the Production of 128 Videotaped Lecture Demonstrations in Introductory Biology

Size and Duration of Award: $271,300 from NSF and $130,342 from the institution for a 3 year project

Date of Award: 1976

Central City Junior College.

Description: A medium-sized community college in the downtown area of a midwestern city

Project Focus: Training a Faculty in Computer Applications to Instruction

Size and Duration of Award: $211,000 from NSF and $150,000 from the institution for a 3 year project

Date of Award: 1977

Ivy University.

Description: Large midwestern university

Project Focus: The Establishment of a Center for Instructional Development in a Large, Research Oriented Institution

Size and Duration of Award: $250,000 from NSF and $170,000 from institution for a 3 year project

Date of Award: 1977

Saints University.

Description: Small black institution, church affiliated, in a southern city

Project Focus: Redesign of Entry-level Courses in Biology, Chemistry, Math, and Physics and Development of the Alternative Pathways to Learning Center

Size and Duration of Award: $236,500 from NSF and $119,077 from institution for a 3 year project

Date of Award: 1977

Willows University.

Description: A senior institution in a nine-university state system in the south

Project Focus: The Development of Innovative Approaches to Laboratory Instruction in Psychology Through the Use of Computer and Television Technology

Size and Duration of Award: $250,000 from NSF and $276,558 from institution for a 3 year project

Date of Award: 1978

Site Visits

Bay College.

Description:	A small, private, church-related liberal arts college located in a small town
Project Focus:	Development of an interdisciplinary approach to teaching science by the "discovery method".
Size and Duration of Award:	$123,400 from NSF and $61,687 from the institution for a 3 year project
Date of Award:	1977

Blue Meadows State College.

Description:	A small rural junior college, one of 12 in the state
Project Focus:	Establishment of a learning center
Size and Duration of Award:	$70,600 from NSF and $61,000 from the institution for a 2 year project
Date of Award:	1978

Clay College.

Description:	A small private, church-related 4-year college
Project Focus:	A comprehensive revision of the analytical chemistry program
Size and Duration of Award:	$95,500 from NSF and $33,250 from institution for a 3 year project
Date of Award:	1976

Coastal University.

Description: A large state research university, one member of a well-developed state university system

Project Focus: Education for furthering environmental cognizance and training, department of geography

Size and Duration of Award: $225,800 from NSF and $95,622 from institution for a 3 year project

Date of Award: 1976

Elms College.

Description: Medium size urban commuter college in the southeast

Project Focus: Reform of freshman biological science laboratory courses

Size and Duration of Project: $141,600 from NSF and $44,005 from institution for a 3 year project

Date of Award: 1976

Hilltop University.

Description: A private, urban, Jesuit university

Project Focus: The upgrading of the electrical engineering department in the area of computer principles and applications

Size and Duration of Award: $143,378 from NSF and $71,690 from institution for a 3 year project

Date of Award: 1978

Maples County Community College.

Description: A large community college serving a large city and its environs

Project Focus: Adapting social science courses to the seminar approach

Size and Duration of Award: $176,790 from NSF and $89,028 from institution for a 2 year project

Date of Award: 1978

Marigold College.

Description: A Catholic, liberal arts college of approximately 1500 full-time students

Project Focus: Improvement of astronomy courses through the development of an observation facility

Size and Duration of Award: $30,900 from NSF and $15,455 from institution for a 1 year project

Date of Award: 1977

Rock College.

Description: Small religiously-affiliated college in the northeast

Project Focus: Preparation for the physical sciences (remedial instruction in mathematics)

Size and Duration of Award: $13,050 from NSF and $7,215 from institution for a 3 year project

Date of Award: 1976

Sage City College.

Description: Large community college in a western state

Project Focus: Instructional uses of the computer in the physical sciences and engineering

Size and Duration of Award: $101,400 from NSF and $87,727 from institution for a 2 year project

Date of Award: 1977

Sands College.

Description: Small liberal arts college in the midwest

Project Focus: The creation of a laboratory center to support the expansion of a science curriculum

Size and Duration of Award: $100,000 from NSF and $60,500 from institution for a 2 year project

Date of Award: 1977

Sea University.

Description: Small private liberal arts institution in a southern city

Project Focus: The development and implementation of a center for instructional computing

Size and Duration of Award: $249,500 from NSF and $172,000 from institution for a 3 year project

Date of Award: 1977

Springs University.

Description: Large state-supported university in the midwest

Project Focus: The development and evaluation of alternative curriculum utilizing individualized and computer-based instruction, an intern program and a science center

Size and Duration of Award: $289,100 from NSF and $295,545 from institution for a 3 year project

Date of Award: 1976

Spruce College.

Description: State supported community college in the southwest

Project Focus: Individualization of course materials for chemistry, biology and mathematics

Size and Duration of Award: $38,100 from NSF and $20,412 from institution for a 1 year project

Date of Award: 1977

Sycamore Community College.

Description: Large community college in the northeast

Project Focus: The development of curricula and the training of faculty in computer science

Size and Duration of Award: $28,540 from NSF and $15,509 from institution for a 1 1/4 year project

Date of Award: 1977

CHAPTER ONE
ANALYSIS OF FINDINGS FROM VISITS TO CAUSE PROJECTS

ANALYSIS OF FINDINGS FROM VISITS TO CAUSE PROJECTS

Introduction

The purpose of this chapter is to summarize the evidence gathered from the site visits and case studies of 25 CAUSE projects and to highlight important observations emanating from this evidence. These site visit and case study reports themselves (presented in Chapters One and Two of this volume) provide the best means of understanding the nature of the projects. The present chapter is not meant so much as a summary of the data included in these reports but instead, as an overall summary of our findings from the 25 sites visited. As such, some of the material contained in this chapter is not necessarily contained in the 25 reports, nor are all data in the reports summarized here. In the preparation of this chapter we have used in addition to the data contained in the reports data from field notes made during the conduct of the visits to the projects. The reader is cautioned, therefore, not to presume this chapter is an alternative to reading the site visit and case study reports as a means of gaining a complete understanding of the 25 projects.

This chapter is based solely on the results of the site visits and case studies and does not take into account the findings from other data sources which this evaluation has utilized. It was developed through a long and iterative series of discussions among the evaluators, science educators, and cost analysts working on the study. These discussions began with the first visits to the projects and have continued beyond the preparation of the site visit and case study reports. In May, 1980 a meeting of all study participants was convened at which time the data emanating from the site visits and case studies were discussed. Subsequently, each of the evaluators has had a direct hand in the analysis presented in this chapter.

The chapter is organized around the five issues which have driven the overall evaluation. As is discussed in Volume One, these issues were derived through a logical analysis of findings derived from an initial series of visits to CAUSE projects conducted in the planning phase of this evaluation, from NSF documents and from the evaluation solicitation. Over the course of this study our understanding of the meaning of each of these issues has evolved as our understanding of the nature of the CAUSE projects themselves has evolved. The five issues represent five different perspectives from which to view CAUSE projects. As such, they sometimes overlap in terms of topics covered, but they are not redundant with respect to how each topic is treated. The five issues are:

Issue One: To What Extent Have High Priority Institutional Needs Been Addressed by Local CAUSE Projects?

Issue Two: How are CAUSE Projects Being Implemented?

Issue Three: To What Extent is the Improvement of the Quality of Instruction Occurring as a Result of CAUSE Projects?

Issue Four: What is the Nature and Quality of the Evidence and Evidence Collection Procedures Being Used to Determine the Strengths and Weaknesses of Individual CAUSE Projects?

Issue Five: What are the Relative Costs of the Design, Implementation and Operation of Activities Within CAUSE Projects, and How do These Costs Relate to Post-CAUSE Institutional Support?

In the text of this chapter specific sites are referenced with respect to various statements of findings or conclusions.

The reader should note that all applicable sites are not necessarily cited in these references; the sites referenced are used for illustrative purposes. The reader should also note that although a particular site is referenced in this chapter, the specific report pertaining to that site (in Chapters One and Two) will not necessarily cover the relevant finding or topic in additional detail. As was previously mentioned, the present chapter is based both on the data contained in these reports and on additional data from field notes generated during the conduct of the site visits.

Issue One: To What Extent Have High Priority Institutional Needs Been Addressed by Local CAUSE Projects?

This issue is one of four explicitly addressed in each site visit report. It is also an important focus in each of the case studies. Its importance in the overall evaluation of the CAUSE program relates to the strong emphasis the CAUSE program places on locally defined institutional needs. The requirement of matching funds from institutions and of the formal statement of institutional support for the project during and after project implementation reflect this emphasis.

The site visitors' descriptions of needs addressed by specific projects and the assessment of their priority within the host institutions relies heavily on the perceptions of the persons interviewed at the respective sites. Perceptions of need are necessarily value-laden in that they reflect the views of present and previous faculty, staff and students as well as the context and history of the institution itself. For this reason we felt it would be foolhardy and presumptuous to attempt to determine during our brief visits what the "real" needs of the institutions are or should be. Rather, we worked to clarify the perceived needs of the institution as reflected in the actions and rhetoric of persons related to each project and to clarify relationships between perceptions of the institution's needs and of the needs served by the projects.

This summary of the findings presented in the 25 site visit and case study reports is organized around three questions. These questions deal with the nature of the needs served by CAUSE projects, the relationship between institutional need and project success, and whether NSF dollars are necessary to support the projects funded by CAUSE.

What Is the Nature of the Needs Served By CAUSE Projects?

Because of the diversity of needs served by CAUSE projects it is impossible to develop a single characterization of them. Rather, this section describes the range of needs in terms of a number of dimensions used by project participants and site visitors in discussing needs. (The reader is referred to Volume III, chapter 2 of this report for a more detailed analysis of the types of needs described in the original proposals of all funded projects.)

The 25 projects vary with respect to the level of need they address; i.e., whether the need is characterized as a deficiency of students, of courses or curricula, of faculty, or of the institution itself. Roughly half of the projects deal directly with the needs of students, such as insufficient basic skills (Elms College, Rock College, Bay College), insufficient familiarity with computer technology (Hilltop University, Sea University, Sage City College) or difficulties adults experience upon re-entering the classroom after many years of absence from the academic setting (Maples CCC). About half of the sites focus on deficiencies of courses or curricula, such as the lack of sufficient instructional alternatives (Cedar State University), the need to cut attrition and increase achievement in entry-level science courses (Saints University) or the lack of meaningful laboratory experiences in introductory courses (Elms College, Willows University). While only a small minority of projects focus primarily on faculty development needs (Central City JC), some projects address faculty deficiencies to some extent (Clay College). A minority of the projects deal with needs characterized primarily in terms of deficiencies of the host institution or large segments of it. For example, at two smaller institutions the projects fill a critical facilities development need (Sands College, Forestview College), and at another, the project addresses the need, in part, for the capability of providing laboratory courses to very large numbers of undergraduate liberal arts students (Willows University). About half of the projects deal with several different levels of needs (Springs University, Cedar State University, Spruce College, Clay College).

In general, the needs addressed by the 25 projects are not unique among science departments or among the 25 sites themselves. Those needs which are relatively unique are most often related to distinctive characteristics of the institution. For example, at Sands College the need for a basic laboratory is unique in that virtually no laboratory facilities had previously existed at the college. The need for the Spruce College project is related to the dispersion of the campus' 33 facilities over 21,000 square miles. The needs served by the Bay College project relate to the "very inadequate high school science backgrounds" of its rural students.

The degree to which project-related needs are recognized and acknowledged by faculty and staff is an important variable among projects visited. In five or six cases, the needs are not generally recognized within the institution and the project's principal staff serve as missionaries, promoting recognition for and attendance to the need. This was obvious at Ivy University where faculty had to be convinced of the utility of a systematic approach to instructional development; at Sea University, where faculty had to be encouraged to utilize computer technology in their instruction; at University of the River where faculty had to be convinced of the utility of adding mediated supplements to their courses; and at CCHEI where they needed to be convinced of the value of adding computing to their courses. In about as many cases the needs served by the project were strongly perceived and supported by virtually all personnel interviewed (Forestview College, Sands College, College of the Mountains, Spruce College, Valley University, Saints University).

The needs addressed by projects vary in terms of scope (i.e., the degree to which the needs relate simultaneously to multiple facets of a project's focus--the students, the faculty, the facilities, the curriculum, related courses across disciplines, the present and the future, etc.). While many projects focus very specifically on an identifiable area of need (Valley University, Rock College, College of the Mountains, Sands College), many others give the initial impression of trying to incorporate every science faculty member's ideas (Coastal University). Indeed, some of these actually accomplished little because resources were spread too thinly (Springs University). However, others of these have prospered and have been catalysts for a variety of improvements

(Forestview College). A related variable useful in understanding these differences is that of comprehensiveness (i.e., the degree to which the various needs are interrelated, and the degree to which these interrelationships are recognized and designed into the project). While a large number of projects are of fairly broad scope only a relatively successful minority of the projects appeared to also be comprehensive (Forestview College, Cedar State University, Saints University).

The priority of needs served by projects within the institutions is generally high. In most cases the projects received adequate support from either the faculty (Hilltop Univeristy, CCHEI), the administration (University of the River) or both (true in the large majority of cases). In two or three cases the need was absolutely critical to the state of science education at the institution (Forestview College, Sands College, Spruce College). In about as many cases it appeared that if the project disappeared the institution would suffer little loss (Ivy College, University of the River, CCHEI). Most sites fall somewhere in between these two extremes.

Determining the apparent priority of needs within institutions involved subjective judgments but also relied on indicators of support for the project such as the participation of faculty and administration in the proposal development process (Sands College, Saints University), the conduct of similar activities prior to the proposal (Willows University, Saints University), the release of key staff from actual responsibilities (Cedar State University, Saints University) as opposed to merely adding project duties to existing responsibilities (Ivy University, Coastal University), and the consideration of participation in the CAUSE project relative to promotion and tenure decisions. (See Cedar State University for negative examples.) For those projects visited near the end of the grant period, continued support after the grant was also considered an indication of the priority of needs served by the project. Of those sites visited within six months of the end of the project (or after its termination) most appeared that they would continue to be supported by the institution.

What Is the Relationship Between Institutional Need and Project Success?

The relationship between institutional need and project success is a fairly direct one to the extent that the need is perceived as being of high priority and is thus given institutional support. Most projects cannot function well without the commitment and support of at least some faculty members and one administrator. (See Elms College, Willows University, Saints University, and Maples CCC for some positive examples.) Some projects have been carried off virtually single-handedly (Bay College, Blue Meadows State College, Rock College) but these are extreme cases that only unusually energetic and/or dedicated persons can carry off. Because it is an individual battle, the project faces the danger of extinction if the individual leaves the institution (Bay College).

The most successful projects seem to rely heavily on the joint and coordinated contributions of time and energy of faculty (Cedar State University, Willows University, Saints University). Such faculty support has been difficult to obtain where participating faculty are not assisted in their responsibilities (Ivy University, Sea University, CCHEI, Forestview College) or when participation in the project is considered a professional liability (Ivy University, University of the River). This is probably more true in curriculum development projects than in facilities development projects.

Vertical or administrative support for projects is more subtle and comes in the form of encouragement for initiation of proposal development, release from normal responsibilities, assistance in staffing and facilities procurement, and promotion and tenure deliberations. Nevertheless, experienced faculty are adept at reading administrative signs and signals and know when they are working with or against the system. While successful project directors and staff are generally independent, lack of administrative support undoubtedly takes its toll in terms of the availability of human and other resources to carry out the project (Ivy University, Forestview College, Bay College).

The role of the institutional statement of support, the formal manifestation of institutional commitment, seems to play some role in promoting project success. While these statements are usually too general to use as a means of holding an institution accountable for specific actions, they do provide project directors and staff a slightly stronger base on which to stand firm. In one case, the project director felt the institutional needs statement in the proposal had helped to maintain the institution's commitment to the project (Spruce College). In some cases the requirement to justify needs has encouraged deliberations about needs during the proposal development process (Cedar State University, Willows University, Hilltop University).

Are CAUSE Dollars Necessary to Implement the Projects Presently Funded by CAUSE?

The previous discussion of needs has been in terms of the needs served by CAUSE projects. The site visitors also investigated the question of whether the dollars supplied by CAUSE are necessary to enable the institutions to carry out the proposed projects. At no sites did the visitors feel that the project could have been carried out at its observed level without the CAUSE funds, and only at two sites was it felt that the project would have occurred anyway but over a longer period of time (College of the Mountains, Sage City College). In the large majority of cases the visitors felt that the funds were absolutely necessary to carry out a significant number of project activities. At many of these it seemed clear that the only way which the project could have occurred at any level was through the initial investment of a large amount of resources (Sands College, Cedar State College, Elms College, Saints University, Maples CCC, University of the River). It is clear that CAUSE funds are needed by institutions to accomplish the proposed tasks.

The reasons for this are fairly obvious. Most institutions of higher education are operating in a steady-state if not retrenchment mode. Even at those that are currently experiencing increased enrollments, preparations for a reduced number of students in the coming decades are underway (Willows University). Resources of the significant amounts provided by CAUSE cannot be found elsewhere in university budgets. When these funds do exist for large capital investments, sciences must compete with other departments for them. This competition is hindered by the fact that sciences often have lower student enrollments than other departments. In addition, course and curriculum development are not perceived as capital investment projects which require a large chunk of money for successful accomplishment.

Prior to the site visits, the site visitors as a group could probably be typified as having some bias against projects with larger equipment and facilities components, especially against projects which appeared in their proposals to be only for acquisition or renovation. Almost all of the projects we visited which had significant equipment and facilities expenditures appear to us to be justifiable and to have been needed. In some cases the need was acute (Sands College, Forestview College); in another less so but still important (Coastal University).

Summary

The needs served by CAUSE projects are as varied as the institutions, their students and faculty. Although needs are not always explicitly considered, even by project staff, high priority needs are being served by CAUSE projects. Institutional need plays an important role in project success in terms of the support and commitment engendered. Furthermore, conscious consideration of needs during the proposal development process provides the starting point for the development of a comprehensive project -- and as noted under Issue Three, comprehensive projects are the most effective projects.

Issue Two: How Are CAUSE Projects Being Implemented?

One of the main purposes of this evaluation has been to develop some understanding of how CAUSE projects are actually implemented. Project proposals present diverse strategies for addressing various science education needs. These proposals are necessarily brief and incomplete, however, when it comes to describing implementation plans. Furthermore, there is no way of knowing from just reading the proposals whether these plans ultimately prove to be realistic and whether they are able to accommodate unforeseen difficulties and opportunities.

The foregoing descriptions of 25 projects has been presented partly to develop some understanding of the nature of project implementation. From these descriptions, it should be obvious that it is difficult to offer any single set of findings as to what project implementation entails; the diversity among institutional settings, science education needs, and CAUSE project activities is simply too great. Nevertheless, some attempt must be made to summarize the observations and identify important characteristics from the mass of data gathered on project implementation through visits to the projects. Therefore, while the preceding chapters of this volume provide a picture of project implementation which is valuable for its completeness and accuracy, the intent of this section is simply to outline some of the more important and better understood aspects of implementation.

The following material is organized into three parts. In the first, the overall process of project implementation is reviewed with specific attention to certain critical variables in the general flow of project events. This is followed by a brief consideration of implementation as observed in practice as compared to the plans in the original proposal. Finally, separate treatment is given to each of a number of important individual factors in project implementation ranging from the attributes of good project directors to the handling of release time.

What Is Involved in CAUSE Project Implementation?

Examination of project implementation requires some understanding of the overall process of a project and those aspects which fall under the label of "implementation". As the evaluators and scientists have come to view implementation in visiting the projects, it involves the conduct, operation and management of a project irrespective of its particular objectives or chosen means of achieving those objectives. For example, whether a project is focused on designing computer-assisted instruction or producing videotapes as its means of improving biology instruction, there are certain commonalities in the conduct of a project that constitute its implementation activities. The nature of implementation concerns can be further clarified through outlining the overall process of a project. In spite of all the differences among the projects and institutions visited, it is possible to characterize the implementation efforts of almost any CAUSE project in terms of four chronological phases: proposal preparation, project beginning, project execution and project transition. Each of these periods has its own particular implementation activities.

Proposal preparation. Project implementation begins with the preparation of the proposal because it is during this period that initial expectations are set and decisions made that will affect the direction and success of all subsequent activities. In the great majority of the projects visited, the project director had a major role in writing the proposal. In a number of cases the project director worked almost alone at this point (Bay College, Blue Meadows State College, Coastal University), but in others s/he shared proposal preparation responsibilities with an administrator (Maples CCC, University of the River, Springs University) or worked as one of a team with the faculty who were to participate in the project (Clay College, College of the Mountains, Saints University). In a very few cases (Sage City College, Valley University, Elms College), the proposal was not really a result of the efforts of the formally designated project director. Instead, one or more of the other faculty members on the project was performing the functions of the project director, and the formal title had been given to the person believed to be most credible in that position (in all three cases, the current department chairperson). For this discussion of project implementation, the three project directors who functioned in this capacity in name only will not be considered; whenever "project director" is mentioned, it refers to the person who actually fulfilled the leadership role.

Before there could be a proposal, there had to be a conception of the kind of instructional improvement that was desired. The origin of the idea to conduct a specific type of project, however, is generally difficult to determine. In a few instances, the conception of the instructional improvement that was to be the heart of the project was largely the idea of one person (Cedar State College, Bay College, Rock College, Maples CCC). More generally, however, the conception of the intended instructional improvement was widely held either throughout the relevant academic area (Valley University and College of the Mountains) or across the institution (Forestview College, Sands College, Central City JC, Spruce College).

For faculty who are generally unfamiliar with proposal preparation, applying to CAUSE for the first time required a considerable amount of effort. Particularly at some of the smaller more teaching-oriented institutions, proposal writing is not a common activity and the CAUSE proposal sometimes represented the first time that faculty in a particular department had ever applied for external funds (Rock College, Spruce College, Blue Meadows State College).[1] Assistance in proposal preparation obviously came first from CAUSE program guidelines. These guidelines reportedly were helpful and led some project directors to consider aspects of project management and evaluation they otherwise would not have. In some cases, the comments of reviewers of nonfunded proposals were of help in preparing a resubmission in a subsequent year (Forestview College, Central City JC). When someone was available locally with grant writing experience, that person might help to polish or tighten the proposal, but generally the project's originators (project director, associated faculty and occasionally an administrator) maintained complete control over the proposal's contents.

A reasonable amount of time and attention was devoted to planning for the actual conduct of the project during the proposal preparation period. This planning, however, did not generally go beyond that required to complete the proposal. The extent to which these plans provided an adequate basis for even beginning the project varied considerably according to whether the project director had previously conducted a similar activity.

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[1] There were a few instances where another NSF program such as LOCI had been the first occasion for this kind of proposal (Maples CCC, Forestview College).

Those projects which were planned by a project director experienced in the relevant activity, such as curriculum or course development or production of audio-tutorial modules (Saints University, Cedar State College, Willows University, Sea University, College of the Mountains) were a lot more realistic in their plans than those which were not planned by such a director (Elms College, Spruce College, Bay College, Ivy University). In one case the project director had accomplished course redesign by himself but had not organized and managed discipline development teams with faculty from other campuses before (Maples CCC).

Finally, one of the most important activities during the proposal preparation period is obtaining the involvement and agreement of all important parties in the project. Obtaining necessary vertical and horizontal support by getting people to "sign off" on the project at this time is sometimes important to subsequent smooth execution of project plans.[2] At such projects as Spruce College and Saints University it was important that the project directors were able to hold administrators or faculty (respectively) to earlier commitments in order to complete the project to the level of detail and specificity planned. Participation in project decisions at this early stage may also be an effective way to gain faculty support for an innovation or change in instructional activities (Central City JC, Cedar State University, Hilltop University).

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[2] The Local Review Statement at the beginning of the proposal is the standard way by which at least some vertical support for the project is insured. In the few cases where vertical support later came into question, the existence of this statement was of help to project directors. In only one of the 25 projects visited was there any evidence that an administrator failed to provide the kind of support indicated by the proposal.

Project beginning. Between the time the proposal is submitted and the notification of award, typically little occurs relative to the implementation of the project. Projects seem almost to have been forgotten in a few cases, creating a situation where the grant's arrival is a pleasant surprise but one which catches some members of the project unprepared to begin (Forestview College, Clay College, Ivy University, Sands College). On the other hand, a few projects began or continued work on those activites they could accomplish prior to receiving the grant, allowing them to begin the project smoothly (Rock College, Saints University).

Once notification of the reward is received there usually is some delay in getting the project started while the project director works to put the plans into operation. This delay could be a minor or a nonexistent one when project activities are a continuation or extension of some on-going activities (College of the Mountains, Rock College, Saints University), or a major one when it involves new activities like ordering equipment, renovating facilities or making arrangements for release time or other logistical matters (Forestview College, Spruce College, Sands College, University of the River, Valley University). For projects of short duration (one or two years) and tight timelines, this delay can present substantial problems (Spruce College, Sands College). One project involved new activities at the institution and was not part of on-going instructional improvement efforts; however, it was able to start up and stay on its projected timelines (Maples CCC). At least one project had a slow start due to turnover in personnel between the proposal writing and submission and the award of the grant (CCHEI). This slowed the start of the project considerably while staff were hired.

Project faculty unfamiliar with instructional improvement activities and purchasing decisions sometimes find that their initial planning was inadequate. Some projects then take extra time at this point to gather further information and revise their initial plans as necessary. Those that took this extra time to reconsider their plans early in the project seem to have benefited from this action and ultimately conducted projects that surpassed initial expectations (Forestview College, Spruce College, Coastal University, Willows University).

Project execution. The major portion of a project's life, regardless of its intended duration as a single or multi-year effort, is devoted to the execution of project plans relevant to the attainment of the proposal's objectives. Obviously, the particular nature of implementation activities here depends a lot on the size and type of project conducted, but generally this period is characterized by individual faculty working fairly autonomously to complete various pieces of the project with varying amounts of guidance and encouragement from the project director (Sage City College, Sea University, Sycamore CC). Projects which are particularly specific in their intended activities and outcomes (and which sometimes view their CAUSE award as if it were more like a contract than a grant) are more explicit in the direction, management and coordination of day-to-day activities (Cedar State University, Willows University, Saints University, Maples CCC, Central City JC, CCHEI). The directors at these projects seem guided by a clear sense of being accountable to NSF for the accomplishment of all activities and outcomes described in the original proposal.

It is at this point in a project that the adequacy of allocated personnel resources becomes apparent. Many projects have required more time from project personnel than was originally anticipated. This was found to be particularly true if the project emphasized the development of course syllabi and instructional materials (which in the case of Saints University led the CAUSE faculty to consider the articulation among related courses within and across departments) and less so if it was primarily an equipment or facilities acquisition effort[3] (Coastal University, Sands College). Materials development projects almost always require all the personnel time set aside in the proposal, and then some. Additional time requirements are covered through faculty members' personal contributions of weekends, long work days and summers. In a few cases, the size of this unexpected but necessary additional contribution of personal time is so large that it makes the achievement of some project objectives unrealistic. In the case of the CCHEI project no release time, or summer time or replacement faculty, were provided to free up faculty to work on the project. All faculty time was contributed until the project director changed that in the final project year. Typically, the greatest contribution of personal time is made by the project director. Time for project management activities was underestimated on many projects (Saints University, Ivy University, Forestview College). A project director's enthusiasm for the effort usually makes it easier for him or her to devote the extra time necessary to ensure the project's success, but this additional effort sometimes takes its toll in terms of project director "burn-out" (Forestview College, Bay College).

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[3] This is not to say that facilities and equipment acquisition efforts sometimes do not require significant and unexpected contributions of personnel time as noted at Forestview College and Willows University.

Overall, the implementation of most project plans went successfully. Certain "mid-course" corrections to plans and budgets are occasionally necessary (Forestview College, Sage City College, Rock College, Coastal University), but project directors experience little difficulty in obtaining NSF approval for such corrections. The only difficulty that sometimes emerges in this regard is when project directors do not realize that these adjustments should or could be made and proceed almost to the project's end before making the changes (CCHEI).

Projects seemed to be able to afford the equipment and facilities that had been planned project acquisitions. However, in several cases the close match between predicted and actual expenditures was sometimes facilitated through shrewd or creative purchasing practices (Forestview College, Coastal University).

Transition. The execution of project plans frequently continues to the full extent of the project's planned duration, but at some point the project more or less gradually enters its final period of implementation activities: the transition from an externally funded special effort to that of an existing, locally maintained increment to the science program's instructional resources. The nature of this transition depends largely upon the nature of the project's improvements. A project which mainly results in the addition of equipment or facilities is not likely to require much of a transition effort to turn over the responsibility for maintaining these improvements (unless they require a substantial increase in some area of the institution's operation expenditures as in the case of Central City JC's new computing capability). Most projects seem to be designed from the beginning with some consideration for the fiscal reality of maintaining the project's improvements in post-grant years. Few of the 25 projects visited (particularly the eight that were subjects of cost analyses) appear to require any significant operation expenditures.

Financial considerations, however, are not the only area of concern during a project's transition to the post-grant period. Of particular importance is the maintenance of vertical and horizontal support for project activities such that those activities will continue in the absence of any sense of obligation to the CAUSE program. Generally, however, the nature of vertical and horizontal support is not a problem at this point either because it is built in from the beginning (Saints University, Cedar State College, Central City JC), or because the project does not require a major change in faculty practice or attitudes as in most of the cases (Marigold College, Sands College) or because the project has allowed faculty to gradually adjust to changes engendered (Willows University, Sycamore CC). The outcomes of the CAUSE projects are generally "supplementary" resources for science instruction. Faculty attitudes have to change in order to use the CAUSE-provided resources, but that change is not mandatory. The CAUSE resources can just be ignored (University of the River, Coastal University, CCHEI). Those few projects where continuation of project improvements in post-grant years is in doubt represent projects which never had strong support vertically from the administration and have lost horizontal support due to faculty turnover (Bay College, Blue Meadows State College). In one case, a particularly innovative attempt to change faculty attitudes and behavior on a wide scale, the apparent lack of sufficient vertical and horizontal support coupled with relatively high continuation expense casts doubt on its ability to successfully complete the transition to the post-grant period (Ivy University). In another case (Maples CCC) the project seems likely to have difficulty making the transition because faculty and students are dissatisfied with the results of the first try-out of newly designed courses. Unfortunately the project is too short in duration to permit a "fix-up" period. Without project provided release time for redesign, it seems unlikely that the new courses and materials will continue to be used after CAUSE. For most of the projects we visited, however, the transition is expected to occur fairly smoothly.

What Is the Relationship Between Projects As Proposed and As Conducted?

It is of obvious interest in a funding program such as CAUSE to determine the extent to which projects as funded match the original descriptions of those projects in the proposals. Some specific discrepancies between project plans and practice have already been noted: unexpected delays at the project's beginning, the occasional need for mid-course corrections in activities and budgets, and the unforeseen demands for project management and materials development time. The following discussion treats some further causes or occasions for discrepancies between plans and outcomes as observed in the 25 projects.

Objectives. As defined in their proposals, objectives for projects visited varied widely in terms of clarity and in terms of their relationship to identified needs and planned activities. In some cases the objectives were rather vague statements of desired outcomes of the form, "This project intends to address these identified needs." In other proposals, however, objectives were more descriptive of what the project was going to do (as in, "This project will create...modules in biology"), than statements of what it hoped to achieve. Projects with vague objectives of the first type make it difficult to judge the relationship between original intents and intents as addressed in the later conduct of the project. Projects with very specific objectives of the second type make it difficult to determine whether the project was actually addressing what they really meant to achieve.

In visiting the projects, we found that virtually all project directors and faculty believe that they are addressing their original objectives. In projects with multiple objectives, one objective might have been partially forgotten or subsumed by another (College of the Mountains), but every project essentially retained its original objectives. The fact that many of these objectives are vaguely stated (Springs University) or focus more on means than ends (Clay College) coupled with the general lack of evaluation data makes it difficult to compare project progress with original intents. Generally speaking, however, all the projects seem to be conducted in pursuit of their original goals.

View of original proposal. In talking with project directors about their objectives two different views of the nature of the original proposal emerge. Some project directors see their proposal as representing a kind of contract. Several years into their projects' implementation efforts, they still refer explicitly to the original plans and objectives given in the proposal and clearly feel that they could be held accountable for fulfilling them (Cedar State College, Maples CCC, CCHEI, Saints University, Willows University, College of the Mountains). Other project directors view their CAUSE funding as more of a grant and the proposal as merely setting the general direction for their efforts. These project directors are thus much less concerned about the specific match between the current status of the project and the statements in the original proposal although they still feel responsible for maintaining the project's original orientation and budgetary guidelines (Coastal University, Clay College). Many other projects, of course, fall between these views of the proposal as contract or grant and they follow their proposed plans as long as they prove workable, sometimes altering the means chosen to an objective but never the objective itself (Rock College, Bay College, University of the River).

Project management. Another factor which seems to influence the match between the project as proposed and as implemented is the management skills of the project director; the better manager s/he is, the better the match. "Management" is being used here in the classic sense as comprising the tasks of planning, organizing, directing and controlling the project. One reason for the good match between proposals and project implementation in well-managed projects may be that the project director is better at planning the project during the proposal preparation stage. Another reason is that good project directors are skilled at organizing, directing and controlling projects during the period of project execution. Those project directors who appeared to be particularly adept managers were at Maples CCC, Coastal University, Cedar State College, Willows University, Saints University, Sycamore CC, Central City JC and College of the Mountains. Good project management skills were, thus, seen as important to effective and efficient project implementation across all types of institutions and projects.

Timelines. One area in which it is particularly easy to note a discrepancy between project intents and implementation is in its timelines. Many of the projects visited have fallen considerably behind their stated timelines and a few have requested extensions to the grant's original duration (Spruce College, Clay College, Cedar State University). There seems to be a number of reasons why a project's predicted timelines might prove unrealistic. First, project plans may not have allocated enough time to specific activities. For example, the projects at Elms College and CCHEI never recognized the amount of time that would be required to complete instructional development activities. Projects such as those at University of the River, Willows University, Springs University, Ivy University, meanwhile, did not provide enough time for equipment acquisition and facility renovation activities. Second, some projects failed to recognize the need to allow time for some things to happen at all (such as certain management activities at the project's beginning) or simply assumed that the project could be completed in less time than was realistic (Elms College, Spruce College, Maples CCC, Blue Meadows State College). Finally, at least one project's timelines proved unrealistic due to events beyond the project director's control--faculty turnovers and institutional crises (Forestview College).

What Other Variables Affect Project Implementation?

In addition to the various factors raised in relation to the overall process of project implementation and to those regarding the relationship between project proposals and actual activities, there are a few remaining variables that figure in the establishment of any CAUSE project and affect its successful implementation. These variables include the treatment of release time and reward structures, the availability of necessary information and expertise, and the characteristics of effective project directors. Each topic is considered in turn.

Release time. Every project needs time from the faculty and the project director to conduct its activities. Since these people are employed full-time to cover their present responsibilities, some means has to be found to make room for a new set of responsibilities on the CAUSE project. This is where the concept of release time becomes important. In the 25 projects visited, release time was an ever-present issue in project plans and activities. The means of obtaining faculty time to work on the project was handled in a slightly different way at each institution.

Perhaps the most common way to provide release time is through a direct reduction in faculty course loads for the time they are working on the project. This is often the clearest way to ensure that faculty can devote a certain amount of time to project activities. Unfortunately, at institutions where faculty have heavy instructional responsibilities each semester (community colleges, small four-year colleges, small departments), a reduction in course offerings can do irreparable harm to the curriculum.

Three solutions to this problem were observed. The first is simply to have another faculty member (not on the project that semester) cover the project faculty member's course. This shifting of responsibilities, however, is only possible where sufficient faculty resources exist within the institution and it was only observed at three projects (Sycamore CC, Springs University, Willows University). A somewhat more common solution is to hire replacement faculty to cover project faculty members' courses for the duration of the project (Sage City College, College of the Mountains, Saints University, University of the River, Cedar State College). This approach assumes that it is possible to hire such replacement faculty, an assumption which proved false at at least one institution (Bay College). A third solution was tried at one institution. At Forestview College students could sign up for independent study with the faculty member and, perhaps, even work on the project during the semester that the faculty member's course load was reduced.

Aside from reducing course loads, another means of providing release time to faculty is to reduce their non-instructional responsibilities such as committee assignments and personal research. Unfortunately, this approach does not seem to result in any real reduction in responsibilities and faculty do not end up with any more time to devote to project activities (Coastal University, Ivy University).

A third means of providing faculty with time to work on the project is to hire faculty to work during summers or other vacation periods (Spruce College, Springs University). This approach seems to be useful only as long as faculty have the resources they need (including access to relevant colleagues) during the periods in which they are working on the project.

From reimbursing faculty for time spent during school vacations, it is a short step to paying for faculty time on an overload basis which is a commonplace practice at community colleges. Only one project obtained faculty release time in this manner (Central City CC) and it created some internal controversy. The difficulty with this approach is that time spent working on the project begins to resemble more of a reward than a responsibility and the situation can become politically unmanageable for the project director. This practice also is questionable in light of CAUSE funding guidelines. At some institutions, however, it may be the only way to obtain faculty time to work on the project.

Across the 25 projects, one means or another was found to provide faculty with release time in all but two cases. In these two cases, one institution failed to award the planned release time (Bay College). The other case involved a consortium effort where no release time was ever planned to cover faculty participation (CCHEI). As might be expected, both of these projects had difficulty maintaining the faculty involvement necessary to achieve their objectives.

Once some means of obtaining release time is found, the next set of difficulties involves the effective allocation of this release time across periods and types of project activity. Some projects find that the particular periods in the project's life during which release time is available do not match the project's overall progress. For example, faculty might find that their release time is assigned too early in the life of the project (perhaps before the necessary equipment purchases have been completed) or too late in the project as at University of the

River where the match between NSF's awarding date and the university's yearly faculty load planning left the project director with no release time for the first year of the project. Other difficulties can arise from spreading release time too thinly over the life of the project so that there is never a critical mass of time available at one point to devote to project activities (as noted by a faculty member on Sage City College's project and by another at Willows University).

Finally, a different kind of release time allocation problem involves the type of activity for which release time is awarded. Specifically, course or materials development efforts are usually accorded release time, but project management and equipment and facilities acquisition activities are not (Forestview College). Given the importance of these latter activities to overall project success, it is unfortunate that the time-consuming nature of these efforts is frequently not recognized. The time demands placed on some project directors with no hope of relief has contributed to the instances of project director "burn-out" observed (Forestview College, Bay College, Spruce College).

Reward structures. In addition to simply providing faculty with the time necessary to do the work, it can also be important to some projects to set up a means of rewarding faculty for their participation. This is particularly true if the project requires faculty involvement in some kind of activity that is of little direct benefit to them or may actually threaten something that is presently valued. The most obvious and extreme example of this situation arises at colleges and universities with strong research orientations. For faculty at such schools, participation in an instructional improvement effort can mean that faculty are not fulfilling their expected role as researchers and, for junior faculty, this can seriously threaten chances for promotion and tenure. One CAUSE project faculty member of those at the 25 institutions we visited had been denied tenure - perhaps partially as a result of his involvement. At other institutions (University of the River, Hilltop University) the possibility of this problem was foreseen and a senior faculty member stepped in to assist the junior faculty member and ensure that the latter had time to meet promotion and tenure agendas.

Probably little can be done to improve the relationship between CAUSE projects and promotion and tenure agendas at research-oriented institutions. Even at the more teaching-oriented institutions we visited, however, there was little evidence of any rewards or recognition being given to faculty for their CAUSE project efforts (Bay College, Forestview College, Rock College). In most projects, the main reward for project participation is simply the acquisition of improved instructional facilities, equipment, or support services. Saints University was a rare and notable exception to this pattern in that public recognition of work at conferences and workshops was provided to project faculty for their efforts.

Information and expertise. Two resources in shortest supply in many projects are the specific information and expertise needed to complete the implementation of project objectives. Some examples of activities and projects where these shortages were observed include: computer hardware purchasing information (Forestview College, College of the Mountains, Willows University and Ivy University) knowledge of instructional development theory of computer instructional materials (Sage City College, CCHEI, Springs University), expertise in the design of instructional television programs (Spruce College and Willows University), instructional development assistance (Ivy University, Blue Meadows State College, Elms College, Rock College, Sea University) and evaluation expertise, particularly formative evaluation found at almost all of the projects visited. In most cases the necessary information and help are simply not available locally and project faculty have to seek help wherever they can find it. (CAUSE project director meetings were sometimes reported to have been helpful in this regard.) There are a few projects, however, in which additional assistance could have been included in the project's implementation plans except that the project director and faculty were not aware that the project could have benefitted from such help (specifically, instructional development and evaluation assistance). Fortunately, only a few projects suffered any serious setbacks due to the lack of information and expertise (e.g., the incorporation of computers at College of the Mountains and the development of a televised chemistry course at Spruce College). Most implementation efforts were just less efficient (or possibly less effective) than they might otherwise have been.

Characteristics of effective project directors. Throughout this whole review of project implementation findings, the importance of the project director to the success of the project has been noted in a number of areas. As the conclusion to this section, it thus seems appropriate to focus on the characteristics of effective project directors as observed in the 25 projects visited. The following are the most commonly observed characteristics (by frequency of occurrence) of effective CAUSE project directors.[4]

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[4] Out of the sample of 25 projects, only two or three could be said to have less than highly effective project directors, so the following observations take into account most of the sample.

Project directors write the proposals. In the great majority of the projects visited, the project director was the primary author of the proposal and, as a consequence, the project as a whole has his or her "stamp" on it to a certain degree. The exceptions to this finding are the projects at Sands College, Ivy University and Springs University where the projects are all fairly comprehensive in scope and the proposal-writing effort included faculty and administrators senior to the project director. The only other exception is the consortium project at CCHEI where the project directorship changed hands several times.

Project directors are senior faculty members. At all but a handful of projects, the project director is a senior faculty member. In over half of the projects, the director is chairperson of his/her academic area or holds a similar post of academic leadership. In the few cases in which a junior faculty member serves as director (University of the River, Bay College, Blue Meadows State College, Hilltop University) the projects are intra-departmental in scope. One of the two consortium projects visited is also not led by senior faculty but by a staff member from the university's computing center (CCHEI).

Project directors are innovators. CAUSE project directors are definitely among the early adopters (in Rogers and Shoemaker's, 1971, sense) of innovations at their institutions. To the extent that a CAUSE project represents an innovative activity locally, then the project director is generally among the first to urge its use by that institution.

Project directors provide strong personal leadership on their projects. This characteristic of project directors is fairly predictable given that they typically wrote the proposal and are thus likely to feel some sense of ownership over the project. The nature of the "strong personal leadership" provided varies according to the demands of the project, nature of the institution, personality of the project director and working relationships among project staff. In general, project directors try to set the tone of the project by encouraging the staff to devote as much energy as possible to the project and by setting an example of hard work on the project themselves. A few project directors assume a lower profile, more collegial leadership style (Clay College, Ivy University, Sycamore CC and Springs University)[5] and in one or two cases the project is more administered than led (CCHEI, College of the Mountains). Earlier in this review, the importance of good management practice to project success was noted. Unfortunately, strong personal leadership is not the same thing as good management and, while there were no instances of totally ineffective project leadership, only nine project directors really represented good managers (including Maple CCC, Forestview College, Central City JC, Cedar State University, Willows University, Coastal University and Saints University).

- Project directors are experienced at the task which is at the heart of the project. This characteristic relates to the observation that if any of the faculty on a project is experienced at the essential task of the project's implementation (instructional development, computer programming, etc.), then it is most likely to be the project director. This is not to say that most of the projects have the necessary expertise at hand because, as discussed earlier, many projects do not. However, some of the most effective project directors are those who thoroughly understand the substantive aspect of the task at hand (Cedar State, Maples CCC, Central City JC, Saints University, Coastal University). An exception to this observation arose in a few projects at larger institutions in which a kind of differentiated approach to project staffing was used to employ specialists at certain points in the project with the project director functioning as overall manager of the staff (Willows University, Sea University).

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[5] Not counting Valley University which was really led by committee.

Project directors are unusually adept at managing institutional politics. This is the last and least frequently observed of the characteristics of effective project directors. It is a characteristic which was noted in approximately half the cases. In these cases the project director's political skills are typically used to gather additional support and resources for the project from elsewhere in the institution. A number of projects get along well without any specific skills in this area, but several projects suffer from difficulties that might have been overcome if the political connections had been better (Bay College, Forestview College, Rock College, Ivy University).

This concludes the section of this chapter on implementation. Overall it should be emphasized that implementation efforts proceeded pretty much as planned. There were, of course, difficulties and unpredictable intrusions. In some areas, project implementation could have proceeded more efficiently and effectively through better project management or more information and expertise, but such deficiencies were almost always overcome by the enthusiasm and hard work of project faculty.

Issue Three: To What Extent is the Improvement of the Quality of Instruction Occurring as a Result of CAUSE Projects?

The above issue is stated as we originally worded it in the plan for this evaluation. Our consideration of the range of possible outcomes of CAUSE projects has encompassed more than simply the quality of instruction. The original sub-issues listed for the issue give evidence for a revised definition. We might have better stated this issue: To what extent are improvements in the quality of science education occurring as a result of CAUSE projects?

Investigation of this issue has included the outcomes, impacts and benefits to science education being derived from the CAUSE program. Given the extreme variety of institutions, academic areas and types of projects involved in the CAUSE program, this is a difficult issue to address. This situation was not made any easier by the fact that a majority of the projects are either still in the process of implementation or are just recently completed and generally lack any evidence which can be used to judge overall change in the quality of educational outcomes. In spite of these drawbacks, the scientists and evaluators (with the help of project directors and other faculty) were able to form some impressions of CAUSE's impacts during their visits to the projects.

The following discussion summarizes our understanding of this issue on the basis of visits to the 25 projects. This discussion is organized around four questions highlighting specific dimensions of the CAUSE program's outcomes, impacts and benefits. These questions focus on the extent to which CAUSE projects are realizing the objectives of the CAUSE program, the likelihood of project improvements continuing after CAUSE funding is gone, the innovative nature of CAUSE projects, and the occurrence of secondary or unintended project impacts on students, faculty and institutions.

Do CAUSE Projects Strengthen Resources for Science Education, Improve the Quality of Science Instruction, and Enhance Institutional Capabilities for Self-Assessment, Management, and Evaluation of Science Programs?

The basic objectives of the CAUSE program as stated in the program announcement are to:

> strengthen the resources for undergraduate science education components of 2-year and 4-year colleges and universities;
>
> improve the quality of the Nation's science instruction at the undergraduate level; and
>
> enhance the capability of institutions for self-assessment, management, and evaluation of their science programs.

In visiting the 25 projects, we have tried to arrive at some understanding of the extent to which these projects represent the achievement of the CAUSE program's objectives. Each objective is considered in turn.

Do CAUSE projects strengthen the resources for undergraduate science education? In our opinion, the answer to this question is unequivocably *yes*. CAUSE funding provides for important improvements to the science instruction resources of colleges and universities that generally would not have been obtained through other sources. These improvements are of four main types: instructional materials, laboratory and instructional equipment (including computer hardware), instructional facilities, and the development of faculty skills in instructionally-related areas. Each of these four types represents a capital improvement to the instructional resources of colleges and universities. That is, CAUSE funding provides for a major, one-time improvement to local science education resources whose benefits will be received by faculty and students over a long period of time. There are a few projects to which this statement does not seem to apply too well for various reasons (Bay College, Rock College, Ivy University), but these generally seem to represent exceptions. In contrast to these few exceptions, we were frequently surprised when visiting projects to find that some of the project elements which, in advance, seemed to be of least relevance to improved instructional resources, would turn out to promise major long-term benefits (e.g., laboratory renovations at Forestview). Overall, a cost-benefit argument could be made in support of CAUSE awards to most projects visited on the grounds of the CAUSE program's first objective alone.

Do CAUSE projects improve the quality of science instruction? This question is more difficult to answer than the first. There is a complex and little understood relationship between improvements to instructional resources and changes in instructional quality. The situation is further complicated by a concern for interpreting or inferring changes in instructional quality on the basis of changes in the capabilities of students at the end of instruction. Given the poorly defined nature of all these relationships and the lack of evaluation data from the projects by which changes in instructional quality or outcomes could be judged, there is no way to answer this question directly. However, certain characteristics observed in the 25 projects do support consideration of a variety of factors that might pertain to any overall judgment of CAUSE's impact on instructional quality.

First, the instructional development efforts of most CAUSE projects visited do result in additions to course and curricula content. These additions involve both new subjects (e.g., the addition of solar energy and environmental assessment topics at Forestview College, the addition of geology as a curricular offering at Bay College) and revisions or enrichment of material presently taught (Willows University, Elms College, College of the Mountains).

Another focus of many CAUSE-supported instructional development efforts is to translate existing courses (or course topics) into some instructional medium other than the lecture or similar approach currently in use. The particular reason for converting this instruction into some other medium varied with the institution involved. In some projects, large introductory science courses were converted to audio-tutorial modules to provide students with a choice in instructional method or opportunity to make up for missed or misunderstood material (College of the Mountains). Other development efforts were intended to improve the efficiency of large-course operation and/or maintain the quality of instruction across sections in a single course (Cedar State Univeristy, Ivy University). Still other projects were conducted so that the availability of alternative media would help to accommodate the instruction to differences in student backgrounds (Elms College, College of the Mountains, Cedar State University, Blue Meadows State College, University of the River, Saints University), or improve the appeal of the course (Bay College, Sea University) or make the course more accessible to learners (Maples CCC). In some cases it was the responsibility of the student to choose to add additional (mediated) instruction to their learning resources (Saints University); in others (University of the River, CCHEI) the faculty selected additional media to recommend to students; and lastly, at some institutions the alternative media were built into the course to be used by all teachers and students.

Computer software development efforts were justified either on the basis that the computer enables students to conduct exercises and experiments that would have been difficult or impossible otherwise (Willows University, Ivy University) or on the basis that students simply needed to become more familiar with the nature and use of a computer (Sage City College, Sea University, Central City JC) or some combination of both reasons (CCHEI). Finally, at one institution, the development of individualized instructional materials was justified on the basis that it provided the only feasible means of delivering a full catalog of courses to a small and widely scattered clientele (Spruce College). Overall, some of these reasons for redesigning a course's manner of instructional delivery appear to represent potentially viable improvements to instructional quality. It is interesting to note that at several projects some faculty seemed to feel forced to use a particular medium and even after working with it on the project expressed a desire to return to more traditional approaches should circumstances allow (Spruce College, Elms College, Blue Meadows State College, Springs University).

Finally, it should be noted that the quality of the instructional materials produced on various projects varied greatly--even within projects (CCHEI, University of the River). Even some of the best run projects failed to produce materials of anything better than average quality in the opinion of the site visitors who reviewed them. It is also interesting to note that very few projects chose to use commercially produced materials although some projects considered them. (Spruce College was a notable exception to this although they made substantial modifications to fit the materials to their environment; University of the River purchased materials but did so only after each item was thoroughly reviewed by the project director and faculty members.)

Overall, it seems likely that some of the instructional development efforts led to improvements in the quality of instruction of one sort or another. However, there is no way to verify this. Furthermore, there was a lack of understanding of the unique instructional capabilities of various media and an amateurish quality to many of the materials created.

Do CAUSE projects improve institutional capabilities for self-assessment, management and evaluation? On the basis of the 25 projects visited, the answer to this question is clearly no. CAUSE projects may improve the management and evaluation skills of individuals at an institution but usually only for one person, the project director, or a small group such as project faculty. It leaves these capabilities of the institution pretty much unchanged; when the individuals leave, their expertise leaves with them. The area of greatest attention (due in part to the program's guidelines for proposals) has been evaluation activities, but as discussed later in this chapter under Issue Four, few successful efforts were found in this area. Some interesting management practices were seen (Willows University, Maples CCC) as discussed under Issue Two.

Do CAUSE-Sponsored Improvements Continue After the End of the Grant Period?

It is not enough for a project to merely result in temporary improvements. Improvements are supposed to last beyond the duration of the grant. On the evidence of the projects we visited, many will (Saints University, University of the River, Coastal University, CCHEI). In many projects

(Coastal University, University of the River, Forestview College) where major renovations have been made in facilities, it would be difficult for the project not to continue. Projects are typically designed to make more or less permanent improvements in a program during the period of the grant. These improvements are such that they require little recurring upkeep and expense in the near future. (It was in this sense that CAUSE projects were discussed earlier in this issue as representing capital improvements.) There are, of course, some exceptions to this generalization--projects in which the improvement requires new resources each year in order to continue to exist (Rock College, Ivy University, Central City JC), or where the project's design or personnel changes make it unlikely that the CAUSE project's outcomes will be visible for long (Bay College).

At a majority of the projects visited, however, there can be little doubt that the essential elements of the CAUSE-sponsored improvements will be maintained. Some of the supporting activities will be dropped, of course, and at some point five or ten years in the future the project's products will have outlived their usefulness and a new effort to replace them may be necessary.

To What Extent Does/Should CAUSE Support Instructional Innovation?

Fostering instructional innovation is not a charge of the CAUSE program. Nevertheless, making improvements in science education programs naturally involves a certain amount of change. For our team of evaluators and science educators, the topic of CAUSE's support for instructional innovation arose in a backhanded fashion as we reviewed proposals for multiple projects doing very similar things (such as developing audio-tutorial biology courses or creating new sets of instructional materials where such already exist elsewhere). We wondered whether CAUSE's funding of similar projects around the country was justifiable on cost-benefit grounds from a national perspective.

It often seemed as though faculty excitement and interaction generated by project activities had the potential to have more impact on the quality of the instructional program than the project's products themselves and this observation was supported by both faculty and student comments at such projects as Forestview College and Central City JC. Another consideration here is that faculty create courses which match the specific and unique needs of their students and meet the expectations of their institutions. There is wide variance in collegiate-level curricula. Local instructional development permits faculty to tailor courses their way.

As to whether CAUSE does support instructional innovation, our response is generally "yes". The problem is with how "innovation" is defined. Even the most commonplace of instructional improvements may be an innovation at some relatively isolated or special purpose institution. In this sense, CAUSE supports innovation.

While CAUSE's present policy towards innovation seems appropriate, we did see projects in which more active encouragement of innovative activities was warranted. In these projects, faculty seemed to be approaching the solution to an instructional problem rather timidly (Rock College, College of the Mountains). Rather than defining a problem and posing its solution directly, these projects were characterized by a kind of sideways approach to change in which, for example, a new set of instructional materials might be created but only instituted on a voluntary basis for those students or faculty who chose to use them as an alternative to the original mode of instruction. It seemed that the cost-effectiveness of some of the projects we visited could have been improved through increased attention to and support of the project as an innovation.

What Are the Secondary and Sometimes Unintended Impacts of CAUSE Projects on Institutions, Faculty And Students?

Our visits to the 25 projects showed that a lot more was happening as a result of CAUSE funding than just the achievement of the projects' stated objectives. At some institutions, the CAUSE project seemed almost to function as a catalyst leading to multiple, continuing and diverse improvements to local science education efforts, Forestview College's and Central City JC's projects being particularly notable examples of this. Listed below are a number of the unintended or secondary impacts of projects we observed.

--At Forestview, the arrival of the CAUSE project's resources provided a major boost to sagging faculty morale at a point when such a boost was critically needed. On a more pragmatic level, CAUSE project funds also turned to serve as seed money with the original $40,000 in NSF funds quickly growing into $500,000 of additional contributions to the college for renovations to its whole science building.

--At Hilltop University, the faculty development seminars in mini- and microcomputers originally intended for the engineering faculty sparked the interest of a wide range of faculty throughout the university. These seminars were so successful they were repeated in an expanded mode.

--The establishment of an instructional computing center at Sea University led to the university's providing virtually all incoming university students with a one-hour orientation on how to access the computer through terminals conveniently located on campus. The students were also provided free computer time and information on the computer games available in the system, a combination which led to a substantial increase in basic computer literacy at Sea University.

--At Central City Junior College, faculty development courses in computer applications reached an audience much wider than the science divisions originally specified in the proposal. Faculty and administrators at Central City JC and at other educational institutions in the area (both secondary and post-secondary) have taken the courses and have utilized the skills learned. The project has sparked interest in computer applications to instruction at several institutions, not merely in the science programs of the project institution.

--At Saints University the course redesign process appeared to be more extensive and comprehensive than described in the original proposal. Faculty had to work together to articulate the relationship among lower division courses within a department and among entry-level courses between departments. The most obvious unintended outcome from CAUSE is that the Math Department now intends to revamp its entire curriculum from top to bottom. This effort began with discussions over entry-level math courses which were being redesigned under CAUSE.

Few overall conclusions can be drawn from these observations of various secondary and unintended impacts except to note that it often seems that it is the creative leadership of project directors and the overall prestige of receiving NSF support that leads to these additional outcomes. Furthermore, it should be noted that not all of the unintended outcomes of CAUSE projects are favorable. Most notably there are several instances of project faculty "burn-out" seemingly due to the increased demands posed by the project (Bay College, Forestview College). Overall, however, the vast majority of unintended impacts were positive.

Issue Four: What is the Nature and Quality of the Evidence and Evidence Collection Procedures Being Used to Determine the Strengths and Weaknesses of Individual CAUSE Projects?

A major objective of CAUSE is "to enhance the capability of institutions for self assessment, management and evaluation of their science programs". The 1977 guidelines for the preparation of CAUSE proposals allowed up to 10% of total project funds to be used for evaluation. The same guidelines took the unusual step of providing prospective grantees a bibliography on current evaluation theory and methods. For these reasons, the evaluation processes of the CAUSE projects were an important focus of each of the site visits and case studies. This section summarizes the findings of the site visitors with respect to this issue.

The discussion in this section is organized around four questions. These questions deal with the strategies which have been used to evaluate CAUSE projects, the perceptions of evaluation held by CAUSE project staffs, the effects of evaluation on the operation of the projects and on the institution's capacity for self-assessment, and problems. associated with the implementation of evaluation activities.

What Strategies Have Been Used to Evaluate CAUSE Projects?

In reviewing the proposals of the 25 sites, we, as site visitors, were impressed with the range of evaluation strategies which had been proposed. Most proposals describe evaluation plans which are relatively extensive in the range of proposed strategies and ambitious in terms of proposed activity level. At most sites, visitors found some congruence between proposed evaluation strategies and implemented strategies but, overall, the evaluations as implemented generally are much less extensive than those proposed and tend to be less important within the overall projects than what seemed to have been implied by the proposals.

Most project proposals emphasize the summative role of evaluation in determining successful attainment of project objectives or in determining the effects of the instructional improvements which are the focus of the projects. The most common strategy utilized at the sites visited is the administration of tests and/or questionnaires to students. In many projects, this strategy is little different from the course and student evaluation activities which normally take place at the institution (Sands College, Blue Meadows State College, Coastal University). At other sites, this strategy is incorporated into a more comprehensive experimental or quasi-experimental evaluation design (Saints University, College of the Mountains, Cedar State College). The more elaborate evaluation designs tend never to materialize in practice, however, generally because of difficulties in setting up an experimental situation in the normal instructional operating procedures of the institution (Rock College), lack of expertise in conducting such studies (Forestview College), or because of a general disinterest in attending to the details of conducting such studies (Willows University, Elms College).

Another common strategy employed is to utilize the services of an outside person or agency to conduct evaluation activities. In some cases, faculty or graduate students from within the institution but separate from the project take responsibility for the evaluation (Cedar State University, Sea University). At other sites, persons from neighboring institutions with evaluation or content area expertise serve this function (Central City JC, Sands College, Sage City College). The role of the outside evaluator varies from project to project. Some sites utilize the opportunity to bring in a well-known expert or panel of experts in a science content field (Elms College, Hilltop College, Sage City College, Coastal University). In these cases, the outsider(s) generally serves both as an "expert reviewer" of project activities and as a professional resource for project staff (Saints University, Central City JC). In a few cases, persons with expertise in the field of educational evaluation are utilized (Willows University). Their involvement usually consists of conducting unstructured interviews with project staff (Central City JC) or, in fewer cases, the establishment of specific evaluation issues to be addressed and the supervision of data collection activities (Marigold College).

Another evaluation strategy utilized by some project directors is basically a managerial approach of setting clear tasks to be completed by project participants and monitoring progress toward the achievement of those tasks on a routine basis (Maples College, Willows University, Sage City College). This strategy seems to serve important communication and control functions as well, assisting project particpants in remaining clear about their obligations and allowing the project director to maintain control over the project's progress.

Most project proposals say very little about the formative, or improvement-oriented role of evaluation. In some projects, however, formative evaluation proved to be the predominant focus of evaluation activities. At some sites, relatively formal procedures are used, such as regular solicitation of student ratings (Cedar State University, Saints University, University of the River, Maples College) or the setting up of a peer review/critique system for materials development (College of the Mountains, Maples College, Willows University). Some of the most effective strategies appear to consist of informal activities, many times implemented on an as-needed basis. Such strategies include requests for colleagues' criticisms of scripts before television production (Cedar State College), the regular day-to-day observation of students working through newly designed laboratory materials (Elms College), informal discussions between project directors and faculty members about proposed course development plans (Willows University), or in a logical analysis of the relationship between course objectives, content, and exams (Saints University).

What are Project Staff Perceptions of Evaluation?

Overall, the staff of the 25 sites visited appeared to have a rather limited understanding of the role which evaluation could play in their projects. Most are quick to agree with the tenet that evaluation is an important thing to do, but there is a great deal of uncertainty of what evaluation means for their projects.

Several project directors remarked that they weren't very sure about "what NSF wanted" in evaluation (Saints University, Springs University, Forestview College, Spruce College). Several remarked that they found the evaluation guidelines provided by NSF (particularly those in earlier funding years) confusing and too much attuned to evaluation jargon. Some directors commented that scientists are not trained in educational evaluation and should not be expected to know how to conduct an evaluation (Clay College, Cedar State University). Others seemed apologetic for their lack of knowledge, and were eager to learn more from the site visitors about what evaluation is and what it means (Bay College, Forestview College).

At some institutions evaluation is perceived by project faculty as somewhat threatening (Willows University, Ivy University, Sycamore CC). These problems are somewhat ameliorated at projects where the project director (or the evaluator) takes care to involve the faculty in the design of the evaluation, where the feedback regarding the evaluation results remain a relatively private matter between the faculty and the evaluator, or where the evaluation is conducted by the faculty member him/herself (Willows University, Elms College, Cedar State Univeristy).

Many project staff express the opinion that formal evaluation activities are for the most part not very useful (Springs University, Sea University, Spruce College). This perspective is understandable given that in many instances, data are collected but never utilized. In these instances, evaluation data appear to be collected for the sake of collecting it, with little attention given to the questions of who needs the data or what decision(s) the data might inform.

In most cases, project staff simply do not care about evaluation. Many think of it as a necessary evil, or just another example of bureaucratic meddling. Another project director's perspective on evaluation, albeit a minority one, is that it is not necessary to worry about evaluation very much. Several project directors reported little or no evaluation on their projects and didn't seem concerned about it (Coastal University, CCHEI, Spruce College).

There are certainly counter-examples, however. The data collected at Cedar State University became the focus of a number of research studies supervised by the project director. The project director at Elms College anxiously watched over his students' shoulders on a daily basis to determine how to improve his audio-tutorial lab; he revised some of his modules four times on the basis of such data. The project director at Willows University regarded the arrival of the project evaluator as a key turning point in the project. These positive perceptions of evaluation seem to be in the minority, however.

What Are the Effects of Evaluation on the Operation of CAUSE Projects and on the Institution's Capacity for Self-Assessment?

Unfortunately, it is difficult to identify very many meaningful impacts the CAUSE program's emphasis on evaluation has had on the operation of CAUSE projects or on institutional capacities for self-assessment. Although some individual projects have benefitted from evaluation data (Elms College, Willows University), most have not. In those instances where adequate evaluations are conducted, one suspects that institutional capacity for self-assessment already existed prior to the CAUSE project (Cedar State University, Elms College). A significant exception is at Willows University where the involvement of external evaluators actually led to the increased use of the project's internal evaluator whose position has now been guaranteed by the institution for two years past project completion. At Saints University, evaluation was well executed and well used; it was difficult for the site visitors to judge how extensive institutional capabilities were before CAUSE.

It does not appear that there have been any significant negative effects of project evaluation, other than the expenditure of resources that could have been used for other project activities or the possible negative attitudes engendered toward evaluation through the requirement of participation to no personal or professional benefit.

Issue Five: What Are the Relative Costs of the Design, Implementation and Operation of the Activities Within CAUSE Projects, and How Do These Costs Relate to Post-CAUSE Institutional Support?

The CAUSE program is a funding program. An evaluation of its efforts must consider the effectiveness of its funding activities in achieving the program's goals. This study has specifically focused on understanding the impact of CAUSE funds from the perspective of the individual project. An analysis of the costs of eight selected projects has been conducted in order to describe the kinds of expenditures supported by CAUSE funds, the effects of requiring a matching institutional contribution and the likelihood of continued institutional support for the funded improvements once the period of CAUSE support is over.

Before beginning to summarize the cost findings, it must be noted that this information has been compiled from a much smaller sample of projects than was true of the preceding four issues. Rather than consider all 25 projects, cost analysis activities were conducted at the eight projects selected as longitudinal case studies. As a result, we feel we have a sufficiently detailed and accurate understanding of resource use to make some statements about these eight projects, but this sample is small and the difference in project resource allocation and consumption patterns is so great that it is extremely difficult to offer valid summaries and generalizations for the eight projects, let alone for all the other CAUSE projects not visited. The conduct and reporting of the cost analysis has presented some particularly insidious methodological difficulties, as it is far too easy to manipulate cost data to construct inter-project comparisons with high face validity but little substantive meaning. Therefore, at a relatively early point in conducting the cost analysis we abandoned any attempt to standardize the directions of our investigations and each cost analysis effort was allowed to pursue those cost issues of particular relevance in that study. The individual reports which resulted (contained within each case study report in Chapter 1, Volume II) should be read to develop a detailed understanding of CAUSE project resource utilization. The following discussion is primarily devoted to a narrative treatment of the cost findings.

How Are CAUSE Funds Used?

Although this is a straightforward question, it cannot be answered simply. A number of points that can be made in response to this question are raised here. As background to this discussion, Table 1 presents one of the few certain and comparable pieces of project cost information, the proposed costs of the eight projects studies as given in their CAUSE proposals.

Table 1

Proposed Project Costs by Funding Source

	Source				
	NSF		Institution		
Project	Budgeted	As % of Total	Budgeted	As % of Total	Total
Cedar State University	$271,300	67%	$130,242	33%	$401,557
Central City JC	210,811	58	149,700	42	360,511
College of the Mountains	186,275	93	14,902	7[a]	201,177
Computer Consortium for Higher Education Institutions (CCHEI)	132,200	66	68,935	34	201,165
Forestview College	241,392	67	126,696	33	362,088
Ivy University	250,000	59	173,846	41	423,846
Saints University	250,000	59	173,927	41	423,927
Willows University	250,000	47	276,558	53	526,558

[a] Amount of college's contribution was unrealistically low due to manner of release time calculations. A more standard appraoch to the costing of this item would raise amount of college's planned (if not budgeted) contribution to over $50,000 or 21% of the (adjusted) budget total.

In studying the projects, we investigated how the projects' resources were actually used and the match between predicted and actual expenditures.[6] Overall, two findings emerged in almost every case: (1) the project's funds (both NSF and institutional) were carefully used following the original budget in the proposal, but (2) the original budget almost always understated the project's true costs.

The single largest item in most project budgets was the cost of personnel time (ranging from a low of 31% of the total project budget at Forestview College to a high of 62% at Central City JC). Nevertheless, it was this area that was most consistently underbudgeted. There were three specific kinds of personnel activity whose demands were underestimated in preparing the budgets: project management (Forestview College, Saints University); equipment purchases (Forestview College); and instructional development (Willows University, Cedar State College). There was one project (CCHEI) where the size of the budget was not as significant a problem as was the allocation of its resources to the various functional areas of project activity. The original budget provided no resources for faculty time on software development efforts but this problem has since been corrected. The only projects in which there were no major differences between budgeted and actual personnel time allocations were those at the College of the Mountains and Ivy University.

In contrast to the resources for personnel time, original allocations for equipment and facilities expenditures were almost always adequate. At several institutions, project directors were able to obtain more for their money than had been planned as a result of hard bargaining and careful purchasing decisions. The best example of this was at Forestview College where they were consistently able to do such things as obtain four "new" laboratory benches instead of the three budgeted by renovating rather than replacing the existing benches. They also were able to get more for their money in scientific and audio-visual equipment purchases.

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[6] We did not attempt to conduct (and tried to avoid any impression of conducting) an audit so as to gain as complete a picture of true project costs as possible.

Overall, we found that CAUSE funds generally supported the design and investment expenditures necessary for capital improvement-type projects. That is, whether they were instructional development efforts or additions to equipment and facilities, most projects represented a one-time allocation of resources to accomplish a specific kind of improvement that would continue to provide benefits in the future with little or no marginal recurring costs to the institution for its operation. The only exception to this was Ivy University whose CAUSE-funded improvement primarily represents a recurring operational expenditure both during the project and in the future.

It generally seems unlikely that any of these institutions would have been able to devote the amount of resources necessary at one particular point in time to accomplish the instructional improvements represented by these projects. None of them (except Forestview College during its cash crisis) appeared to have any difficulty in providing their matching funds (the allocation of which was generally spread over three years). Generally the "return-on-investment" was too great to allow administrators to worry where the money was coming from. If there were some internal stealing from Peter to pay Paul to come up with the matching funds, Peter never knew what he was missing. Some particular aspects of the matching fund requirement are considered further below.

Matching Funds and Contributed Resources: What Are the Additional Costs of Conducting Projects?

Matching funds. With a few exceptions, CAUSE has required a one-third commitment of matching funds for projects from institutions. At the eight projects studied, the institutions' budgeted contributions generally ranged from 33% to 53% of the total budget. (The College of the Mountains was an exception, but, as was noted, the contribution should really be given as 21%.) In every one of these projects the institution met its obligation to the project with little problem. What the original proposal budget did not show was the ultimate extent of resources contributed in excess of the stipulated matching funds. These contributed resources were of two kinds, institutional and personal.

Institutional contribution. Five projects had significant contribution of institutional resources beyond those of the original matching funds promised in the proposal (Cedar State University, Central City JC, College of the Mountains, Saints University, and Willows University). Ivy University and CCHEI only committed what was promised and no more. Forestview College did not increase the institution's commitment to the project beyond what was promised but succeeded in multiplying the impact of project funds several-fold through other sources of external funds. From CAUSE's point of view, the extent and frequency of additional institutional contributions could be taken as sign that CAUSE money acts as a catalyst and serves to generate additional efforts to meet local science education needs. From another point of view one has to wonder about the two cases in which there were no additional contributions to or generation of additional project-related resources: Were those projects so carefully budgeted from the beginning that any additional resources would have been superfluous, or might this be a sign that those projects represented less critical needs than the others? Knowledge of the projects involved suggests the latter interpretation.

Personal contributions. The second kind of contributed resource is personal, that is, the donated (weekend, evening, and vacation) time of project faculty which was committed to the achievement of project objectives. At six projects (all but College of the Mountains and Ivy University) there were significant amounts of donated time. At many of these six it is questionable whether the project could have achieved its stated objectives without the donation of this time to critical project management, equipment purchasing, and instructional development activities. At CCHEI, for example, a small number of module development projects studied showed that an average of 44% of the development costs were contributed by the faculty involved. At Forestview College the project went from several hundred thousand dollars in size to efforts totaling nearly a million dollars with an accompanying increase in the variety of activities but no increase in budgeted time for project management. An article in a recent issue of the Chronicle of Higher Education (July 28, 1980) noted that many higher education institutions are surviving current financial hard-times by drawing evermore heavily upon their stock of personnel resources and that this stock of resources may be depleting rapidly. Some of the CAUSE projects we visited provided evidence for this claim.

What Is the Relationship Between Operating Costs and Post-CAUSE Continuation of Project Improvements?

When we began this evaluation we expected to find that the costs of project continuation in post-grant years would be closely tied to the likelihood of continuation of the improvement. We also expected to find that the recurring costs for operating these improvements might be significant. As a result of our cost analyses of the eight projects, we still believe that the marginal cost to the institution for maintaining the improvements is closely related to the likelihood of their continuation, but we have found that many of the projects were conceived as one-time commitments of resources to accomplish some capital improvement with low or non-existent operating costs in the near future. Specifically the projects at Cedar State University, the College of the Mountains, CCHEI, Forestview College and Willows University have produced improvements with minor or nonexistent operating costs (in excess of the operation costs of the similar pre-CAUSE activity). The value of most improvements (including instructional materials), however, will be consumed or lost over time. At some point five, ten, or more years in the future a new investment of resources will have to be made to replace the present improvement, but this long-term replacement cost is not a primary consideration in the continuation of the present CAUSE-funded improvement.

The operating costs for maintaining the improvements at the other three institutions studied are somewhat more of a concern. At Saints University and Central City JC, year to year operating costs will be moderate but significant (e.g., $50,000 a year at Central City JC). Both institutions, however, express little concern over their ability to maintain their projects' improvements and some of the costs involved represent less of an increment to the overall institutions' budgets than a reallocation of existing resources. At Ivy University the operating costs of continuing the instructional development center are very substantial, possibly amounting to as much as the project's annual cost during the period of CAUSE funding. In this one case CAUSE funds did not support a capital improvement in local science education resources but rather the first three years of an activity that must be funded every year to maintain its primary benefits. Given that Ivy University needed CAUSE support to start their instructional development center (in addition to the fact that the institution provided no additional contribution of resources during the period of the grant), it seems highly questionable that the institution will maintain this improvement in post-grant years.

Summary. Overall, the cost analysis has shown that all of the projects studied spent their money carefully, but most of the projects cost more than originally budgeted with this additional cost being borne both by the institution and the individuals involved. Most of the projects also represented capital improvements with low future operating costs which suggests the likelihood of their continuation is quite high.

CHAPTER TWO
CASE STUDIES OF EIGHT _CAUSE_ PROJECTS

THE REDESIGN OF 3 COURSES AND THE PRODUCTION OF 128 VIDEOTAPED LECTURE DEMONSTRATIONS IN INTRODUCTORY BIOLOGY

Site Visitors: Philip L. Doughty
Marvin Druger
John D. Eggert
Ramesh Gaonkar
Dennis D. Gooler

Primary Author: John D. Eggert

Preface

The CAUSE project at Cedar State University has focused on the refinement of 3 introductory courses in biology and the production of 128 videotaped lecture demonstrations to provide biology students with an additional instructional alternative. The two most prominent characteristics of this project have been the extremely heavy work loads carried by the project staff in developing the 128 videotapes, and the skillful and creative ways in which the project director has established strong and effective relationships with other university agencies and units to their mutual benefit.

We visited the project near its completion, and it was obvious almost at the outset that the project had been very successful. The challenge to us, as we have conducted this study, thus became one of determining why the project succeeded. The reasons for its success are complex, and we undoubtedly haven't discovered them all. However, one primary factor has been the dedication of the project staff and the active support of their colleagues. Another has been the administrative skill of the project director.

The reader will see in this study an example of what can be achieved through the successful coordination of personnel and other institutional resources.

The names of the faculty members and the identity of the university in this case study have been changed to protect their privacy. No real place or people's names have been used.

Introduction

This case study describes the CAUSE project at Cedar State University. The project began in the fall of 1976. The primary outcome of the 3-year project (completed in the Spring of 1980) was a series of 128 videotaped lecture-demonstrations for use in three introductory courses in biology. Related outcomes included the redesign of the biology curriculum and the establishment of an instructional support system for faculty and student use of the videotapes. Funds provided by NSF totaled $271,300, and those committed by the university totaled $130,342.

The Site Visit

This report is based on two site visits by separate two-person teams and a site visit by the cost analyst. In addition, it is based on a review of the unusual amount of documentation available at this project and on written correspondence with the project director. The first visit was conducted approximately six months before the end of the grant period; the second visit occurred approximately two months after the grant expired.

The primary purpose of the first visit was to obtain a general overview of the project and to begin to develop initial hypotheses to be investigated in the following visit. Interviews were conducted with approximately 22 persons including all of the project staff, the vice-presidents for academic affairs and for research; the Dean and Assistant Dean of the Colleges of Sciences and Humanities; three of the chairmen of the science departments whose faculty and students were involved in the CAUSE project; selected non-CAUSE faculty; and representatives of the library, the campus television station (an ABC affiliate), the Media Resources Center, the university testing center, and the School of Education. The first visit was conducted by an expert in instructional design and program evaluation and a science educator. The second site visit was conducted by a new team, chosen for their specific expertise in the areas of educational measurement and research and in innovation in undergraduate biology education. The purposes of the second and final visit were: to investigate issues raised on the first visit (particularly those raised through the project director's comments on the field notes from that visit); to clarify details relating to the day-to-day implementation of the project; to review the educational research and evaluation conducted by the project; to understand the nature of project management and to obtain student input.

The project director was able to provide the site team with an unusual amount of documentation on the project including internal reports, summaries of doctoral dissertations and several published reports. In addition, student study guides and samples of five television tapes created by the project were supplied to the site teams which provided direction to the site visits and to the creation of this report.

The University And The CAUSE Project

The University

The University was founded in a midwest cornbelt state by the Morril Act of 1862 "to promote liberal and practical education of the agricultural and industrial classes in the several pursuits and professions of life." One of the two major state institutions of higher education, the University has a strong reputation in research. Its student population was 21,200 at the start of the grant (up from 20,000 the previous year), and 23,000 at its completion. This was in contrast to a general decline of enrollments across the state.

The biology program, the focus of the CAUSE grant, is an interdisciplinary program composed of students and faculty of the life sciences departments (Animal Ecology, Bacteriology, Botany, Genetics, Biochemistry and Zoology). It is headed by the CAUSE project director who has the title of Program Executive Officer.

The project is somewhat unique among other CAUSE projects visited in its heavy reliance on and collaboration with a variety of other university agencies including the ABC affiliated campus television station, the university library, the University Media Center and the Professional Studies Program of the School of Education. The relationship of the project to each of these agencies will be discussed more completely later in this report.

The Problem

Instruction in undergraduate science at the university is similar to that at most other large universities in terms of its heavy reliance on large lecture classes for its introductory courses. Biology 101 (one of the three courses directly involved in the project) enrolls 3200 majors and non-majors per year in lecture classes of 200-400. The other two courses together enroll an approximately equivalent number. With the gradual increase in enrollments has come an increased diversity in student characteristics. Concern for this diversity as well as an interest in efficiency has led to a variety of experimental approaches to large group instruction over the past several years.

The interdisciplinary nature of the biology program has presented particular challenges to the design and implementation of innovative responses to these problems. The diversity of departments has naturally led to a diversity of priorities in terms of course content, emphasis and method of instruction. The large number of instructors involved in the introductory courses and their regular turnover has made coordination and standardization difficult, as has the fact that each biology faculty member has also had loyalties and obligations to a home life-sciences department.

Previous Responses

The project director had experimented over a period of five years with a modified mastery learning plan, the Phase Achievement System (PAS). This system is described in the project proposal:

> The plan, the Phase Achievement System (PAS) is based on modularized course content outlined in published objectives and instructionally supported by large lecture sections and an audio tape library. Examinations are offered repetitively outside of scheduled class time and are computer assembled in a modular format corresponding to the eight course units. Students may take the examination modules in any order or grouping up to five times during the enrollment period. Examinations are scored by units, and grades are based on a policy which requires that students achieve a minimum score on each unit and pass a minimum number of units before receiving a specific grade for the course. Students progress through the course as seen in the flow diagram [in proposal appendix]. PAS is supported by a computer-based data processing system designed to score examinations and keep student records and to generate master copies of the examinations from an existing 2500 entry multiple choice question pool. (Proposal, p. 5)

The general intent of the experimental approach, which was applied to several sections of Biology 101, was to work toward the development of a model strategy for large group instruction and, more specifically, to enlarge the number of instructional alternatives available to individual students. Initial research seemed to indicate that the approach was workable and in some instances would actually lead to a decrease of the negative effects of certain individual differences. For example, test anxiety, an apparently important mediating variable related to test performance, seemed to be lessened through the PAS testing strategy.

The CAUSE Solution

The success of the PAS system led the biology staff to consider its implementation across all three introductory biology courses (Biology 101, Biology 103, and Zoology 155). A number of problems prevented the department from expanding the program on its own. The start-up costs would be relatively large, particularly since there was general dissatisfaction with the quality of the audiotapes (often only direct recordings of actual lectures) and alternative media would have to be considered. The heterogeneity of the biology staff as well as the practice of rotating teaching assignments for introductory courses would pose problems to course standardization (an important first step in modularizing courses and creating a computer-based testing system) and would force the addressing of issues related to the interrelationships of the three biology courses. In general, upgrading the model instructional approach from experimental status to full-scale implementation would require a systematic approach to the design of a total instructional system and would require the coordination of a variety of activities including hardware procurement, software design, curriculum development and the nurturing of a variety of relationships with other university agencies. An approach of this complexity would necessarily require an initial outlay of start-up funds unavailable within the normal departmental budgets. Thus, a project was designed and a proposal submitted to NSF in support of the general goal of "...establishing a model instructional strategy at the University which will improve undergraduate biology instruction for majors and non-majors in large lectures (N>150) by providing for individual differences." The following were listed as specific project objectives:

1. To completely reassess what is taught in the first year of biology to cull redundancy and assure continuity.
2. To create detailed behavioral objectives for students.
3. To establish question pools that are referenced to the behavioral objectives and which will be used in computer assembling examinations.
4. To develop high quality video cassette instructional materials at remedial, average, and advanced concept levels.
5. To evaluate instructional materials in items 2, 3, and 4 as they are used by students in courses.
6. To revise instructional materials as necessary according to student or faculty opinion and changing need within the university.
7. To introduce the PAS concept as an instructional alternative for the first year biology sequence.
8. To evaluate different instructional strategies applicable to large enrollment courses and to counsel students as to which alternative best suits their needs.
9. To experiment with allowing students to select and individually design course content.

Implementation

The following discussion on project implementation is organized into three sections. The first section describes the project in terms of its major components: the primary development team, the modified and expanded PAS system, the curriculum materials, the facilities and supporting personnel. The second section describes the project from the perspective of management and administration and discusses personnel management, intra-institutional relationships, managing curriculum development and other management related topics. The final section on project implementation describes the curriculum and materials development process.

Description of the Project

The primary development team. An important characteristic of the project was the general cooperation and participation of a large variety of personnel from within and outside of the Biology department. For this reason it may be somewhat misleading to refer to a primary development team. However, three faculty in particular were selected to develop and produce the television tapes for the project, an activity that took the greater part of a complete year near the beginning of the project.

The three persons on this team included the project director who assumed responsibility for production of the Biology 101 tapes, Dr. F., who had been the only instructor of the Zoology 155 course for the past several years, and Dr. M., who was given primary responsibility for the Biology 103 tapes. (Biology 101 introduces biology at the molecular through the evolutionary level, Zoology 155 at the organismal (human) level, and Biology 103 at the population-ecosystem level.) These three persons were chosen for their experience with the respective courses and their interest in the project. In addition, they each were skilled lecturers and obviously dedicated and extremely hard workers, attributes which proved to be absolutely necessary for the successful completion of the project. Each of the primary team members worked closely with other biology faculty in curriculum development in general and in the development and review of tapes and scripts in particular.

The Phase Achievement System. The project capitalized on the team's previous experience with the PAS. Specific course objectives were built for each lecture session. These course objectives were originally intended to be expressed in terms of behavioral objectives, but the faculty found it more realistic to instead write them as a series of test-like questions. The questions were compiled into a study guide which also contained brief explanatory materials, and served as the basis for all future course and materials development activities. The original test item pool for Biology 101 was expanded and items were compiled and edited for the remaining two courses. This resulted in a total of over 9000 entries in the computer-based item pool. These items could then be accessed by any faculty member through the submission of a request form specifying the number of versions of the test desired, the number of scrambled versions (i.e., alternate item sequences) of each test, the relevant question pool, the categories from which items should be randomly drawn and (if desired) the specific items the instructor would like to have included in the test.

During the initial academic quarter of the project all of the biology courses were taught in the traditional manner. This was to establish baseline data and to allow project resources to be concentrated on development efforts. During the second academic quarter a self-paced large lecture section of Zoology 155 was given. Video cassette lectures in conjunction with live lectures were introduced to four experimental sections the following year with traditional testing only and, finally, an approach combining PAS and video lectures was developed and investigated in all three courses. (The results of this investigation, to be discussed later, showed that while the PAS provided significant benefits compared to the traditional lectures, the effects washed out when used in conjunction with videotaped lectures. This, along with some logistical inconveniences associated with PAS, led to the dropping of the PAS approach from the system though further experimental uses are contemplated.)

Materials development. In addition to the study guides discussed above, 128 individual video tapes, 19 to 45 minutes in length, were produced by the primary development team for the three courses. They were created at the rate of approximately one tape per week, per person, a single tape reportedly requiring an estimated 40-60 person hours to produce from start to finish. The tapes were completed and in use by the beginning of the second project year and represented a major and intensive effort during the initial year of the project. More will be said about the materials development process later in this report.

Facilities. Four university facilities played an important role in the project. The University Library Media and Microform Center supplied the space for 36 videotape playback units. The Center also managed the circulation of the tapes, maintained the tapes and equipment and provided general logistical support for student use. It has been estimated that the project increased the circulation at the library's Center by over 40% during the project's second and third years. (Over 64,000 tape uses were recorded by the Center during the last two project years.) This growth was viewed as a positive outcome of the CAUSE project by library administration.

The University Testing and Evaluation Service provided the project with test-scoring services, within-class record keeping procedures and computer-based test generation capabilities. This service had always been generally available to university faculty (although specific changes were required for the CAUSE project) and was provided to the project at cost.

The primary production facilities were provided by the ABC affiliated university television station. The final taping, for the most part done with a single take for each tape, was in full color with professional sets and professional quality audio and lighting. Visuals, drafted by the primary team faculty, were put in final form by graduate assistants. Assistance was also provided by the campus media center and a television studio artist.

Other personnel. Other personnel involved in the project included other members of the biology faculty who participated heavily in the overall curriculum design and review process. (Some also participated in the production of some of the tapes.) Faculty not directly involved in the teaching of the courses also provided occasional input, particularly in the area of evaluation. Graduate assistants from the College of Education provided valuable services in the collection and analysis of data related to specific research hypotheses. In general, the primary development team received the support of a wide variety of persons in the design and implementation of the project.

Actual vs. planned activities. The implementation of the project deviated slightly from the original intentions described in the proposal, as is normal in a project of this complexity. As mentioned earlier, the PAS grew to be redundant and logistically difficult. The original proposal also suggested the development of three separate levels of tapes which would allow individual students to be instructed at a level of difficulty and complexity suitable to their abilities and skills. Although individual tapes were classified according to level, the large majority of them fell into the middle classification and the distinctions among classifications came to be regarded as not very meaningful or useful. Furthermore, based on their experience with self-pacing in the PAS (which showed that most students need at least some structure, and many need quite a bit), project staff felt that it would be difficult to counsel and/or monitor the tracking of students in their choice of tapes. Finally, a philosophy of redundancy of the tapes with the lectures eventually won out over an interest in providing different levels of content to compensate for individual differences. The other major deviation, which was incorporated into a formal grant modification in the final year of the project, was to drop objective nine "To experiment with allowing students to select and individually design course content". This objective was dropped as not being well-founded and as being impractical, based on the project staff's experience with the other aspects of the project. Although most readers would probably consider the original proposal to be quite ambitious, it appears that the majority of tasks were carried out in a manner very close to what was proposed.

Management and Administration

Overview. From a management perspective, the unique aspect of this project was not its complexity but rather the degree to which the large variety of personnel and other resources required careful coordination to guarantee the accomplishment of project objectives. A commonly expressed view among project participants was that the project could not have come close to succeeding without the project director's insightful understanding about and skilled management of the diverse resources supporting the project. We agree.

A variety of managerial roles and strategies were required of the project director as he coordinated the various resources utilized in the project through the establishment and nurturance of relationships among individuals and agencies within the university, through the oversight of and participation in activities related to hardware procurement and software development, and through the purposeful dissemination of information about the project. The project director's skill at encouraging the donation of university resources to his project to augment resources already committed was also useful.

Personnel management. It was acknowledged by all that the project director is a skillful manager of people. He was described as a leader, a motivator, a hard worker and a supporter. While he had limited formal administrative powers, his ability to work with people toward the achievement of common goals seemed to provide him with a sort of velvet-gloved power that gave the project impetus and maintained its momentum. He definitely was respected by his colleagues.

A number of strategies could be detected which contributed to the project director's success in personnel management, some of which were planned and purposeful, others which were probably done intuitively and reflect personal characteristics. The project director is a hard worker, and it was said a number of times that he would never ask something to be done if it wasn't clear he had already done at least as much himself.

Furthermore, it appeared that he rarely surprised anyone with a directive but, rather, tended to discuss mutual goals and objectives on a one-to-one basis in advance of a decision to allow for the development of a consensus.

The project director attended to detail, not in the sense that he wasted his efforts on matters that could be taken care of by others, but in the sense that he was very clear in specifying what he expected--tasks, timelines, obligations, etc. He stressed open and clear communications and encouraged feedback if there was uncertainty. He often referred to the NSF grant as a "contract" and stressed the university's obligation to provide what was agreed upon in a form of which the group could be proud.

One cannot be an effective manager without effective people to manage. The project director selected project staff carefully with particular consideration to the most efficient combination for the needs at hand. For the task of development of the tapes he chose two others who were skilled lecturers, quite task oriented, interested in the problem as well as the particular solution and ready and willing to work very hard. He structured the tape development task as an intensive, one tape per week, per person, full-time effort by relatively few persons on the theory that once the group became acquainted with the task they would become quite efficient in performing it. "The worst way to get release time is to teach one class [i.e., one-half load] each quarter", commented the project director. While all acknowledged that it was a very gruelling process, its efficiency was also quite clear.

The danger of isolation of the primary development team (and the possible rejection of the finished products by those not involved in their production) was anticipated and dealt with through a strong emphasis on group participation at all stages of the development process -- the definition of objectives, the writing and review of scripts, and the review of finished tapes. Probably as important as the actual changes resulting from such input and the development of a consensus about what was being done was the perception of virtually everyone associated with the project that their advice had been solicited and would be listened to if offered. It would have been impossible for everyone to review and comment on everything. The key seemed to be that each felt his/her opinions were respected.

Intra-institutional relationships. The role of establishing and nurturing relationships between the project and other university agencies parallels the role of personnel management in a number of respects. Careful groundwork is required to establish a trusting relationship, to become aware of mutual and complementary goals and resources, and to establish clear and open communication. At the inter-agency level the specification of mutual expectations and obligations tended to be clearly documented in an almost contractual letter specifying what resources would be provided in return for what benefits.

The project director seemed to be particularly skillful at capitalizing on the needs and interests of other university agencies. For instance, the Library Microform and Media Center was new and wanted to increase its clientele. The campus television station, always conscious of its relationship to a commercial network, found the project useful as a means of fulfilling its academic obligations to the university. The College of Education's recently established Department of Professional Studies was pleased at the opportunity for its doctoral students to work on meaningful and researchable problems complete with a large and well-documented data base. In each case a key strategy seems to have been one of brokering -- the give-and-take process of determining how the project and the agency could serve each other, rather than how the project might merely use the other university agencies.

A strategy important to both personnel management and to maintaining relationships with other agencies is that of delegation of responsibility. The project director pointed out that neither he nor his staff were trained to do everything well and that it was important to delegate tasks when others could be found who could do them better. This reserved project personnel for those tasks for which they were best suited; i.e., project management and the design and implementation of instruction in biology. This was particularly important in the areas of hardware selection, procurement, and maintenance; media production and library services.

Managing curriculum development. Although the development process will be discussed in detail later, its relationship to project management should be mentioned here. There is probably not an area as sensitive in academic project management as that of determining what should be taught, and how. As far as could be determined from rather extensive interviews, the process of restructuring the introductory biology curriculum was accompanied by relatively few hurt feelings, bruised egos and the like. This seems to be a result of the general atmosphere fostered by the project director and adopted by the individual curriculum committees and sub-committees. In particular, the curriculum development process was characterized by a clearly structured approach to the problem; open, frequent and well-documented communications and an emphasis on the solicitation of the input of others.

Maintaining relationships with external audiences. A specific management goal cited in the project proposal was "...that the project results attain visibility locally and nationally." In addition to the normal desire to inform the field, this goal seemed to be motivated by a recognition that the increased prestige created by such visibility leads to increased support for the project within the institution which in turn increases the probability of the project's long-term success. In addition to supporting five doctoral dissertations and submitting a number of formal publications on the project, the project director maintained a local publicity campaign. "During the first year, if no one wrote a story in the local newspaper within a period of three months, I'd give them a call", remarked the project director. In addition, he regularly lobbied for the project within the university whenever possible.

Overview of project management. It is clear that an important reason for the success of the project was the project director's skill in serving in the multiple roles of the project manager. He took an overall systems view of the project, paying attention to the interrelationships of the parts of the project and the relationship of each to the whole. He thought about what he did and he designed creative strategies for the solution of problems well in advance of potential crises. He solicited and used the input of others and delegated responsibility in appropriate situations. He communicated clearly and kept all participants updated. Probably most importantly, he maintained and efficiently used the power given to him in trust without threatening those with whom he interacted.

The Curriculum and Materials Development Process

History and rationale. Prior to the CAUSE grant the three introductory biology courses were taught somewhat independently. Although a curriculum committee occasionally convened to discuss the content of the courses and their interrelationships, individual faculty were given the normal amount of leeway in content emphasis and pacing within the general course outlines. Zoology 155 was an exception to this generalization in that it had been taught by a single person for several years before the start of the grant. The PAS portion of Biology 101 was also an exception in that lectures and individualized tests were based on a set of instructional objectives outlined in modular form in a study guide.

With the onset of the CAUSE grant, a greatly increased emphasis was placed on the systematic development of objectives, modules, study guides and item pools for each of the three courses. During the fall of the first project year three course committees, each consisting of five different people, met on a weekly basis to discuss course content. According to the project director, a conservative estimate is that 300 person-hours were given in these meetings plus additional preparatory work, the main outcome of which was the set of three study guides. These guides then served as the basis for the selection of items for the item pools and also as the basis for subsequent script development. The meetings also served as a forum in which individual faculty members could express their concerns and needs in open discussions with the persons who would actually write the scripts and do the television lectures. The meetings also led to a clarification of the relationship between Biology 101 and the other two courses, the former being designated as a prerequisite to the latter as a result of these deliberations.

The rationale for the institution of a systematic approach to curriculum development was primarily two-fold. First, the instructional strategy of PAS requires that faculty and students have a common conception of what is expected of students and what each test will cover. Second, the extensive resources to be utilized (including an interdisciplinary staff with differing conceptions of the courses) demanded a systematic approach to the problem to insure that all points of view were considered and all resources were efficiently utilized.

The process. Once the study guides were created the primary development team took on the task of creating tapes for each of the modules. (One tape would be designed to coincide with each topic in the study guide.) First, a script was written based on the guide outline. In the case of Biology 103, the scripts were reviewed by colleagues in related areas. Graphic illustrations were rough-drafted by faculty and produced by a graduate assistant with graphic arts skills. Other support materials such as models, laboratory apparatus and occasionally film clips were also assembled.

When the script was in final form and all the materials were gathered, the faculty member met with the studio crew, discussed the script and went through the entire program once as a rehearsal and a debugging procedure. Then the crew and the lecturer again discussed the script "over coffee" and a final take was made without stopping. Although the project director was able to ad lib his lectures on camera after going through his notes once, the other two television lecturers used a teleprompter. "It's not what you goof on, it's how you recover", commented the project director.

Initially, the tapes were done over once or twice before the lecturers were satisfied with them. However, as each became more skilled and as they became aware of slipping behind in their schedules they began to do all the programs in a single take. In all, only 10 of the 128 tapes were remade. Although the individual lecturers report never being completely satisfied with a given tape, they feel that the data support their adequacy and that the redoing of individual tapes at the expense of not doing other tapes would have been counterproductive.

Following production, all interested faculty were requested to review the tapes using a standard review form. Curriculum committees and subcommittees met semi-formally for this purpose. One faculty member mentioned spending many Saturday mornings on his own performing this task. While this input would most often not have any immediate impact on the reviewed tape, it was used in the preparation and production of subsequent tapes.

Similar feedback was also solicited from students and was used in a similar manner. While most of the faculty feel that most of the tapes will have a useful life of at least five years, there are presently limited plans to revise a few of the tapes in the near future based on student and faculty feedback. After the initial intensive production effort there appears to be a natural reluctance among the primary development team to begin revisions and the general attitude seems to be that resources will be found for revision when it becomes necessary.

Comments on the process and the products. The development process used by the project included many of the stages of most formally articulated instructional development processes. The courses selected for development were of high priority. The content of each of the courses and the relationships between the courses were developed through open consensual processes and documented in an unambiguous manner. A logical rationale was used for the selection of media; and input from others was regularly requested, received and used at various stages of the development process. As will be seen in a following section of this report, a fairly intensive research strategy was used to investigate the overall effect of the approach and had some role in determining subsequent modifications.

The tapes themselves reflect a systematic approach to their development. They are content-rich and the content consistently reflected the course outlines and the lectures according to students and faculty. Students apparently have found them useful, since over 30,000 uses per year have been recorded. One of the site visitors with a limited background in biology viewed five of the tapes and found them interesting and informative.

However, the intensive production effort necessarily led to some things being dropped or overlooked. Although the tapes were produced in professional studios they do not have an overall professional "look" to them. At times the lecturers look noticeably nervous; transitions are not always smooth; more use could have been made of props; there are occasional misstatements or bad word choices and the like. These sorts of problems are to be expected, given the production circumstances, and may only be cosmetic. In fact, one student mentioned that she felt the informality decreased the psychological distance between her and the lecturer.

Some of the tapes we viewed also appeared to have some pedagogical deficiencies, in the opinion of this writer. It would probably have been useful to display new terms on the screen as they were introduced, which was not always done, and the scripts could have used more of an introduction explaining what was going to be discussed and a summary explaining what had been discussed. Some of the slides and visuals are not clear enough and are difficult to read. These are problems based on a single viewing of five tapes, one of which was selected by the project director as an example of one of the worst. These may not be completely representative, but they illustrate the types of problems that could have been corrected if more time had been available to the development team, or if additional review and assistance could have been provided by an expert in this sort of educational media production.

The problems cited in the above paragraph are based on limited data and are not meant as an overall negative evaluation of the tapes. There is ample valid documented data that show the tapes to be instructionally effective. Furthermore, the five tapes do also exhibit very interesting and creative uses of the media. For instance, one used a "Dick Cavett-like" interview format in which film clips are discussed by the project director and a visiting expert. Some of the film clips are quite interesting and, because of their brevity, are practical only in a television format. Many of the visuals are extremely well done, clearly labeled and well integrated into the presentation. As examples of locally produced instructional television, the tapes are commendable. The project director expressed his views on this subject as follows:

> We may not have followed the book as a "professional instructional developer" would like to have us do but we accomplished the task with a high level of performance. Every instructional developer I ever talked to indicates that it would be impossible to produce 100 quality videotapes in nine months. In light of our actual production schedules, our high usage figures and our research results I feel our lack of sophistication was an asset which allowed us to accomplish the impossible, and not a liability...

The project director pointed out a few problems he perceived with the overall process. One was the variability in the length of tapes. While this made scripting and production substantially easier, it prevented the tapes from being usable by educational television stations which require tapes of regular length, preferably of 28½ minutes each. Another problem was that in order to accomplish all of his project management responsibilities as well as produce the tapes for Biology 101, the project director did not solicit and utilize the input of the other Biology 101 faculty as much as he would have liked which resulted in some difficulties. Ideally, according to the project director, he would have preferred to have had several of the other biology staff involved in the actual production of tapes. However, the requirements of efficiency and consistency mitigated against that option.

Evaluation Procedures And Results

The project director made a distinction between research and evaluation in the following statement:

> "Research is the bringing together of literature or data in such a way as to recognize patterns or trends. It lends itself to description and hypothesis testing. Evaluation, on the other hand, renders a value judgment about an activity in a formative or summative manner against some criteria."

In discussing the evaluation of his project, and in reporting about it, he tended to emphasize the role of evaluation for accountability; i.e., to prove that the objectives promised were the objectives achieved. For instance, a program evaluation conducted by several graduate students in an education course with the assistance of the project director listed each proposed project objective in the results section, followed by a numerical rating (1-9) indicating the degree of achievement of the objective followed by a discussion of the data supporting their judgments. (The methodology consisted of the conduct of interviews and the review of project documentation.) In another case, the project director used a similar method of reporting on the evaluation results of his project with letter grades given to each proposed objective. He also rendered judgments on his project in terms of the broader NSF-CAUSE goals relating to impact on the nation's undergraduate science education.

Although the project director's personal philosophy on the nature of evaluation tended to emphasize its accountability function, a number of other activities of this CAUSE project would be considered by many to also fall into the category of evaluation. In particular, the research activities provided important data to support the summative judgments about the project and, to a lesser extent, actually had and will continue to have an impact on the direction to the project. Likewise, a number of formal and informal aspects of the curriculum development process described earlier could be legitimately classified as formative evaluation; i.e., evaluation for the purpose of improvement.

Formative Evaluation Activities

Any good instructor normally incorporates formative evaluation activities into the instructional process although it is probably more often implicitly considered at an intuitive and informal level than it is explicitly considered at a conscious and formal level. This has tended to be the case in the present project.

Although the term "formative evaluation" was rarely used by project staff, most of the previously described developmental activities included data collection activities used to inform improvement-oriented decisions of the development teams. For instance, review and feedback activities were an important part of the early committee discussions of objectives and of study guide content. Scripts were reviewed, in some cases, by other faculty. They were also reviewed by production staff immediately before the first run-through. Critiquing sessions were held between the rehearsal and the taping. Faculty provided go/no-go decisions on each of the tapes before they were used and made suggestions for future tapes. There also appeared to be close collaboration within the primary development team, the members of which were apparently relatively open with each other with supportive criticism. In general, a spirit of informal inquiry and self-questioning seemed to pervade the project's development efforts. Within the context of undergraduate instruction in general, the openness and willingness with which opinions and review of instructional efforts were solicited and received on this project must be considered to be exceptional. This spirit was probably an important factor in the overall success of the project in the opinion of this writer.

One could wonder if a more formalized approach to formative evaluation would have improved the project; for instance, one of the evaluation graduate students, selected for his/her expertise in instructional design and/or media, could have been assigned strictly to the task of formative evaluation. Perhaps the tapes could have been raised a notch or two in overall quality, or perhaps problems that had not been discovered could have been uncovered and dealt with through the formalizing and staffing of the formative evaluation function. Given the openness of the staff, the project certainly would have provided a supportive environment for such activities.

It should be noted that the project director consciously chose an informal approach to formative evaluation. In a letter to this report author he further explained his stance:

> .... It is my opinion that you cannot tell premier faculty what to do. You can criticize past performance and talk abstractly about the future but to appear to look over their shoulders at what is being done now invites conflict. Furthermore, revision of tapes would have taken too much of the precious commodity, time. Formative evaluation was deliberately low key. Quality control then became one of trusting the judgement of my colleagues on the development team. This yielded a good product. Surely, it could have been better but it was not bad to start. Rather than suggesting that future project directors adopt a formal formative evaluation, I would suggest that they ponder the benefits and drawbacks of both formal and informal formative evaluation. A particular project in a particular context may find one or a combination of both to be best.

Research-Based Evaluation Activities

A unique characteristic of this CAUSE project was the degree to which an active program of instructional research was carried out. A team of four doctoral candidates from the College of Education and a very strong faculty advisory group with expertise in a variety of aspects of instructional research worked closely with the project director toward the objective of investigating the determinants of student achievement using the following model[1]:

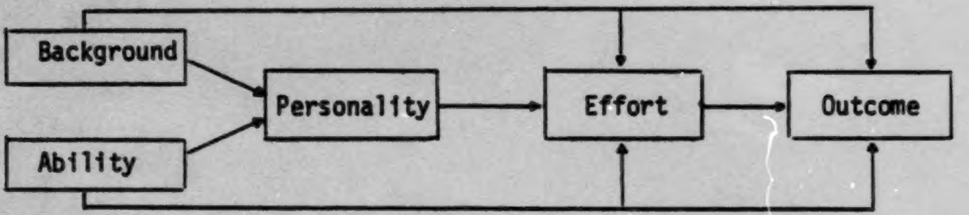

Figure 1. A Model Of The Determinants Of Student Achievement

The actual measurements include the following for each student:

Ability:	ACT or MSAT scores; high school rank; GPA
Background:	High school credits in chemistry, physics, biology, mathematics or college biology
Personality:	Measures of: test anxiety; achievement motivation; locus of control
Study effort:	Time spent using lecture notes, text, videotapes
Other:	Age, gender, non-major - major

This type of data was collected on 4,000 students tested by the traditional or PAS methods with or without availability of the videotapes in each of three courses included in the project, twelve conditions in all.

Of specific interest to the research team were questions related to the differences in relationships between predictor and outcome variables in the various instructional contexts. Baseline data collected on the traditional sections showed, as expected, that ability and background were important positive predictors of grade and that test anxiety was a negative predictor, particularly for female students. Analysis of data collected before the start of the project concluded that the negative effects of test anxiety could be overcome among female students who increased their study effort. A follow-up study conducted by one of the project's graduate assistants concluded (after adjusting statistically for differences in ability and background) that female students who had the beginning course under self-pacing did better in subsequent, traditionally taught courses.

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[1] This section of this report which describes research activities and results, draws heavily on published reports by the project director and by his graduate students. However, references have been deleted to preserve institutional anonymity.

A similar study was carried out in the second academic term of the project. It compared the relationship of high school background and final exam scores in the project's PAS and traditional sections of Zoology 155. The study concluded that the low background students spent more time studying in the PAS section than their counterparts in the traditional section, and that this had a compensatory effect which effectively eliminated the predictive relationship between high school background in science and final exam grade.

Other analyses supported by the project concluded that students were not replacing traditional study activities (i.e., studying notes and reading texts) with television viewing, but were spending additional time viewing the tapes and that this additional viewing time was positively correlated with achievement even after statistically compensating for differences in ability.

Numerous other analyses were performed on the rather extensive and well documented data pool and many more will undoubtedly be performed long after the cessation of the grant. These studies have had and will continue to have a variety of impacts. Several have already been published in professional journals and/or presented at professional conferences. Others have been reported through other communication channels described earlier in this report. The project director reported that biology faculty members sometimes use the results in advising students how to approach the courses. The early studies on the project led, in part, to the decision to drop the PAS component in lieu of the taped lectures. (Analysis showed that tape usage tended to wipe out the effects of PAS.) The research data was also used to support the summative evaluation judgments made by the project director and project evaluators.

Conclusions

The project was implemented as proposed, with some relatively minor exceptions. This in itself is a significant accomplishment given its extremely ambitious objectives. In addition, the evidence shows it to have been accomplished with excellence.

The needs cited in the proposal are legitimate. Indeed, the concern for efficiently meeting the diverse needs of individual students in large lecture sessions is a concern of undergraduate science education in general. The project as proposed and implemented has moved the field a step forward in addressing these concerns.

The project has been very efficiently executed. This is due to two important factors: the dedication of the faculty members involved, particularly that of the primary development team; and the management skills, insights and abilities of the project director. Both of these factors were necessary -- the project could not have succeeded with the absence of either. While the insights and abilities of the project director perhaps are inherent or at least learned over a long period of time, the skills are probably acquirable and a prospective project director would do well to study the various managerial strategies used in this project. The challenge of coordinating all the various resources so efficiently utilized in the project was equally as formidable, although not as obvious, as the production of 128 quality television tapes in the limited time available.

The televised lectures are effective instruction and do meet the individual needs of students in the choices they allow; i.e., whether to rely primarily on the tapes or the lectures, when and how often to view the tapes, what portions of individual lectures need to be studied again and other decisions allowed by the outstanding viewing facilities.

The curriculum and materials development process was an effective one, although some might feel that it might be made more explicit at various points. The non-formal, less explicitly articulated approach to the development process worked in this project because of an apparently intuitive sense for the process among those involved, particularly the project director and the primary development staff. It might not be as effective in other contexts. A more explicit model, even if not closely adhered to, might help participants to identify oversights or redundancies in the process.

The evaluation process shared some of the non-formal characteristics of the development process. While the summative evaluation activities and the research activities which supported them were quite explicit in purpose, execution and documentation, the formative evaluation activities were less straightforward and generally had quite a lower profile within the project. While it is not obvious that the project suffered because of this approach to formative evaluation, it is possible that more attention paid to formative evaluation could have led to even higher faculty project outcomes. The value of a clearly formulated model of formative evaluation within a project may be similar to that of a clearly stated development model.

A natural question to ask is "Why television?" Apart from the obvious reason that television is what was proposed and funded on this project, there may be others. Audiotapes were tried but were deemed unsuccessful by faculty. It is not clear to what extent other formats were considered but given the unique set of resources available on campus (the commercial television facilities and the library media center in particular) the choice seems to have been an appropriate one. The efficient manner in which the 128 tapes were developed, in retrospect, also made the choice a good one. The use of television allowed a critical mass of instructional media to be accumulated rapidly which in turn allowed the project to progress and become institutionalized during the course of the project. It should be noted, however, that without the resources available at this university a similar project might not be as successful.

The project has become institutionalized, the most striking evidence of which is the over 30,000 tape uses per year, uses which are not mandated by faculty but reflect 30,000 individual decisions by students to avail themselves of the opportunity. The introductory biology curriculum which initially provided the direction for the development of the study guides and tapes now has a more uniform consistency and increased stability because of the materials. According to students, faculty use them to pace their lectures. New faculty are introduced to the department and the curriculum through the course materials. The public and documented nature of the curriculum, on a lecture by lecture basis, supports continuing discussions of the curriculum among faculty. While there will at some point be a need for the revision of the tapes, the degree to which the instructional system is already institutionalized suggests that resources will be found to accomplish the task when they are needed.

Project Costs

In contrast to the narrative data provided by the scientist and the evaluator, this section of the report focuses primarily on the project's use of resources translated into budget figures and categories. Although a functional task-oriented interview approach was employed to collect much of the personnel allocation data, monetary costs are not reported according to project functions or activities. This was deemed not useful since no resources were allocated to program (or course) operation and pre-operation activities (development, production, test development, field testing, and research/evaluation). These were so confounded that attempts to split these joint endeavors would have led to questionable results. Instead, the cost analysis section contains a description of procedures used to collect cost-related data, results of estimates of actual time spent by project personnel, results of other charged and contributed expenditures, and a discussion of relevant cost-related implications.

Procedures

One member of the evaluation team, Philip Doughty, served as the cost analyst for this study. Data reported herein were obtained via personal interviews on site with the three primary project faculty members as well as discussions with representatives of the two heavily involved service components (the library media center and the television production facility). In addition, documented budget reports of expenditures for materials and services were used as sources for other cost data. Although cost figures for personnel time were available both in the proposed budget and in official university records of contract charges to NSF, attempts were made to collect more detailed estimates by interviewing key project members.

Focused interviews with each of the three primary team members were conducted so that they could review their calendars for the past two and one half years and reconstruct their professional time allocation in a diary format. They were asked to identify the various CAUSE project-related activities that occurred during each academic quarter and then also identify the major university-funded activities separate from the project. In some instances, joint or overlapping activities were allocated proportionately to each.

In general, activities identified by project members could be easily grouped into the following functional categories:

1. Design/Planning;
2. Development/Production/Evaluation;
3. Operation/Instruction (including routine course management of field test courses); and
4. Project management.

Regular project and institution accounting systems were not organized functionally and thus did not reflect the reality of professional time allocation to project and university activities. Comparisons between the formal institutional financial reports and data obtained via interviews help in this instance to demonstrate the extremely heavy work load experienced in the first few stages of the project and then a gradual (and perhaps merciful) diminishing of personnel time and other resource expenditures in the later stages.

Other expenditures documented in this report reflect those costs not usually contained in a conventional budget report or in the project final report. Although imprecise and subject to personal bias on the part of interviewees, estimates of personnel time and other less well-documented contributed resources are included as additional evidence of institutional support provided to the project. These include particularly the support provided by the institution's library and the television production facility.

Results

Resource allocation information for this project is reported in several different but complementary ways. The first table (Table 2) presents the project's budget as originally proposed to CAUSE. Table 3 presents an inventory of the actual tasks and time required to complete those tasks as reported by the project personnel involved. Table 4 focuses just on personnel expenditures and presents the actual funds expended on all project personnel and replacement faculty during the conduct of the project. Finally, Table 4 compares the levels of personnel effort as proposed (from Table 2), paid (from Table 4), and actually expended (from Table 5). It should be noted that, while the estimates of actual time spent do not always match the official expenditures, these differences are not significant. Furthermore, as noted on Table 5, these level of effort estimates to a certain degree conceal the extent of contributed university resources and professional personnel time.

It was particularly interesting to compare the first year's professional workloads with those of subsequent years.

Table 2

Cedar State University's CAUSE Project
Original Proposed Budget

Line Item	NSF	Cedar State	Total
Salaries, Wages and Benefits			
11. Director.	$ 21,668	$ 10,419	$ 32,087
12. Professional Staff.	32,832	19,024	51,856
13. Assistants.	23,500	9,450	32,950
15. Secretarial and Clerical.	13,608	--	13,608
16. TOTAL: Salaries and Wages	91,608	38,893	130,501
17. Staff Benefits (when charged as direct costs)	11,649	5,553	17,202
18. TOTAL: Salaries, Wages and benefits (16 & 17)	103,257	44,446	147,703
Other Direct Costs			
20. Staff Travel & Publication.	2,345	--	2,345
22. Laboratory and Instructional Materials. . .	74,059	--	74,059
23. Miscellaneous Supplies, Communications. . .	2,050	--	2,050
25. Production of Tapes	42,000	66,350	108,350
26. Test Scoring and Evaluation	600	--	600
27. Consultant.	1,200	--	1,200
28. TOTAL DIRECT OPERATING COSTS.	$225,511	$110,796	$336,307
29. INDIRECT COSTS.	45,804	19,446	65,250
30. TOTAL OPERATING COSTS	$271,315	$130,242	$401,557
31. TOTAL CONTRIBUTED BY INSTITUTION. . .		$130,242	
32. TOTAL AWARD FROM NSF	$271,300		

Table 3

Inventory of Reported Project Tasks
and Time Expenditures

Person/Period	Tasks	Time Spent[a]
Project Director		
-Pre-Project (7/76 - 8/76)	Planning and administrative meetings; hiring temporary instructors; procuring sample videotapes; ordering materials	.50 FTE[b]
-Year One, Fall 1976	Form project team	
	Curriculum planning - meeting teachers, planning study guide, planning production, reviewing tapes, developing test question pool	.40
	Produce first draft study guide	.20
	Project management	.15
	Total	.75 FTE
-Winter 1977	Curriculum planning - begin videotape production (20 hrs/tape)	.55
	Project management	.25
	Total	.80 FTE
-Spring 1977	Produce Video-tape programs and experiment with testing	.50
	Project management	.20
	Total	.70 FTE
-Summer 1977	Recruit and train new instructors and new research assistants; develop new test files; produce videotapes (.30 FTE); procure video equipment; plan library setup (.30 FTE)	.85 FTE
	Average for Year One	.78 FTE

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[a] As estimated in the percent of professional time devoted to task.

[b] FTE = Full Time Equivalent for one academic period.

Table 3 (cont'd)

Person/Period	Tasks	Time Spent[a]
Project Director (cont'd)		
-Year Two, Fall 1977	Develop/produce videotapes (10 FTE); revise study guide and question pools; direct graduate student research on project; project management	.50 FTE
-Winter 1978	Project administration; direct evaluation effort	.55 FTE
-Spring 1978	Project administration and evaluation	.40 FTE
-Summer 1978	Project administration, direct research, plan for following year	.50 FTE
	Average for Year Two	.49 FTE
-Year Three, Fall 1978	Teach two experimental sections of the course (.30 FTE); direct research on course implementation; evaluation of course and learning outcomes; project administration and coordination	.70 FTE
-Winter 1979	Project administration, research and evaluation	.33 FTE
-Spring 1979	Project administration, research and evaluation	.33 FTE
-Summer 1979	Research and evaluation, and final report writing	.60 FTE
	Average for Year Three	.49 FTE
Assistant Professor M.		
-Year One, Fall 1976	Organization-planning for development; recruitment and working with graduate students on visuals; work on examination format and questions; editing exam questions; consulting with television station representative; consulting with test scoring; designing internal project evaluation strategy; planning & design of the course study guide (to help guide video production)	.65 FTE

Table 3 (cont'd)

Person/Period	Tasks	Time Spent
Assistant Professor M. (cont'd)		
-Winter 1977	Work on exam questions; development and tryout of two trial tape productions	.50 FTE
-Spring 1977	Tape/program production (30 tapes); exam question editing	.70 FTE
-Summer 1977	Tape production; build file of slides for video productions and for instructors (not a part of the formal proposal but all team members did this); revise study guide	.80 FTE
	Average for Year One	.66 FTE
-Year Two, Fall 1977	Videotape production (including weekends--scripting, visuals, etc.)	.80 FTE
-Winter 1978	Production of advanced course tapes (which were used for the regular course as well); broadcast new advanced BIOS SERIES on television station as spinoff of regular course; revise exam questions	.90 FTE
-Spring 1978	Production of advanced tapes; completion of slide file for instruction for classroom use; review of evaluations of video tapes--regular series; exam question file completion; implement computerization of exam files	.30 FTE
-Summer 1978	Continue with BIOS tape program production (advanced series); exam questions--review/rewrite/revision	.25 FTE
	Average for Year Two	.56 FTE
-Year Three, Fall 1978	Re-edit question bank; field test computer file test items	.30 FTE

Table 3 (cont'd)

Person/Period	Tasks	Time Spent
Assistant Professor M. (cont'd)		
-Winter 1979	Edit test questions using data from field test; collect more data on tests with more students	.25 FTE
-Spring 1979	Review student comments on course materials and tests; revise BIOS tapes	.15 FTE
-Summer 1979	Complete program evaluation; continue revising BIOS tape series	.10 FTE
	Average for Year Three	.20 FTE
Associate Professor F		
-Year One, Fall 1976	Project planning and design; curriculum planning; course committee coordination	.50 FTE
-Winter 1977	Develop course study guide; develop course objectives and video scripts; begin developing test question pool; coordinate with media services developers	.60 FTE
-Spring 1977	Script development; preparation of graphics for video; video production	.85 FTE
-Summer 1977	Production of videotapes; revise question pool; revise study guide; review and revision of test items and course materials; review of course feedback from students	1.0 FTE
	Average for Year One	.74 FTE
-Year Two, Fall 1977	Evaluate course components as implemented; teach (field test) one course section; implement the self-paced testing (PAS) system; develop recordkeeping system for course; produce three remaining video programs	.60 FTE

Table 3 (cont'd)

Person/Period	Tasks	Time Spent
Associate Professor F. (cont'd)		
-Winter 1978	Review course feedback data from previous quarter; revise recordkeeping system; staff development (train faculty in new course format); follow-up on students with incompletes from prior quarters	.40 FTE
-Spring 1978	Assist new instructors in implementing new course; followup on use of course materials in field test classes; disseminate results (progress to date) at annual meeting of midwest college biology teachers	.20 FTE
-Summer 1978	Revise study guide, adding figures, graphics, etc.; add to test item pool; develop scripts for new advanced course series	.50 FTE
	Average for Year Two	.43 FTE
-Year Three, Fall 1978	Design and conduct course evaluation with graduate assistants; teach one large experimental section incorporating the self-paced testing component	.40 FTE
-Winter 1979	Course evaluation - including review from Fall quarter; prepare reports for national and regional presentations; followup on students with incompletes	.25 FTE
-Summer 1979	Produce two programs for advanced series; publish final version of study guide; prepare final student manual for fall; complete copyright release procedures; plan course staffing for fall	.25 FTE
	Average for Year Three	.28 FTE

Table 3 (cont'd)

Graduate Assistants

Year One, September 1976 - June 30, 1977

Three graduate assistants were funded by the project and two were provided by the university. During the first two quarters of the 1976-77 academic year all five devoted their time to project design and planning. Full-scale development and video production began in the spring quarter and each GA spent essentially 100% of his/her project time on those tasks during that time period.

Year Two, July 1, 1977 - June 30, 1978

Although budget reports show seven different individuals worked on the project as GAs during the 1977-78 year, there were four essentially full-time assistants, two of whom were responsible for development and production. The other two devoted their efforts to research, testing and evaluation efforts related to the project.

Year Three, July 1, 1978 - June 30, 1979

The final year of the project called for considerable research and evaluation support from the GAs. The project provided resources to cover one assistant plus one-third of another. The College of Education contributed the remaining two-thirds of that assistantship. In addition, the Biology academic program contributed one full-time assistantship in order to have three full-time evaluator/researchers.

Table 4

Official Record of University Expenditures For Project Salaries and Wages

	Salary and Source			
Line Item	% Salary to Grant	Charged to NSF	% Salary to Cedar State	Cost to Cedar State
11. Director				
Year One	--	--	76%	$16,196
Year Two	--	--	55%	12,650
Year Three	--	--	33%	8,121
12. Associate Professor F				
Year One	--	--	66%	12,032
Year Two	--	--	56%	12,975
Year Three	--	--	25%	6,140
12. Assistant Professor M				
Year One	--	--	57%	9,619
Year Two	--	--	53%	11,501
Year Three	--	--	25%	6,053
12. Replacement Faculty[a]				
Year One				
Temporary Instructor #1	100%	$11,000	--	--
Temporary Instructor #2	75%	8,250	--	--
Year Two				
Temporary Ass't Prof #1	100%	11,500	--	--
Temporary Ass't Prof #2	100%	12,000	--	--
Year Three				
Temporary Ass't Prof	100%	12,500	--	--
13. Graduate Assistants[b]				
Year One				
Graduate Assistant #1	100%	4,050	--	--
" " #2	--	--	100%	4,050
" " #3	100%	4,050	--	--
" " #4	100%	4,050	--	--
" " #5	--	--	100%	3,240

[a] The cost of replacement faculty was used as the basis for project personnel costs in proposal budget (although they were not listed as part of the budget per se). These temporary instructors replaced project faculty in the classroom so that they could have the release time necessary to fulfill project tasks.

[b] Percent salary cited for the period in which they worked, not necessarily for the whole year.

Table 4 (cont'd)

	Salary and Source			
Line Item	% Salary to Grant	Charged to NSF	% Salary to Cedar State	Cost to Cedar State
13. Graduate Assistants (cont'd)				
Year Two				
Graduate Assistant #1	100%	$ 405	--	--
" " #2	100%	709	--	--
" " #3	100%	203	--	--
	100%	2,600	--	--
	65%	1,305	--	--
Graduate Assistant #4	100%	607	--	--
" " #5	--	--	100%	$ 4,980
" " #6	100%	405	--	--
	100%	2,500	--	--
	50%	1,290	--	--
	100%	430	--	--
Graduate Assistant #7	--	--	100%	3,990
Year Three				
Graduate Assistant #1	--	--	100%	4,250
" " #2	--	--	100%	415
" " #3	71%	3,000	29%	1,200
" " #4	100%	1,200	--	--
" " #5	100%	430	--	--
" " #6	100%	3,060	--	--
15. Secretary and Clerical				
Year One	--	4,963	--	--
Year Two	--	4,604	--	--
Year Three	--	3,023	--	224
TOTAL ALL PROJECT-RELATED PERSONNEL COSTS (Including both project faculty and replacement instructors, but excluding benefits)		$94,579		$122,386

Table 5

Comparison of Proposed, Paid and (Estimated) Actual Professional Personnel Time on Project

Personnel	Year	Level of Effort As: Proposed[a]	Paid[b]	Actual[c]
Project Director	One	.67%	.76%	.78%
	Two	.50	.55	.49
	Three	.33	.33	.49
Associate Professor F	One	.50	.66	.66
	Two	.50	.56	.56
	Three	.25	.25	.20
Assistant Professor M	One	.50	.57	.74
	Two	.50	.53	.43
	Three	.25	.25	.28

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[a] As proposed in project's original proposal. This and all other percent estimates represent level of effort for total year.

[b] As shown in the official records of university expenditures for the project. Cost of this time was paid for out of Cedar State's budget so any increase over proposed levels represents a further contribution on the university's part.

[c] As based on faculty estimates of the time actually spent on project tasks. It is interesting to note that the first two columns of this table assume a 40-hour work week as the basis of the level of effort calculations. Level of effort estimates in this third column, however, are likely to be based on a 50- or 60-hour work week. This means that the estimates in this third column actually disguise some considerable additional expenditures of "donated" professional personnel time.

Discussions with project personnel showed that although the proposed and reported salary expenditures matched fairly well, the actual percentage of time (and especially the actual hours of time) devoted by the three faculty members was much higher. Normal work weeks for each of those faculty during the first year reportedly averaged 55-60 hours. Thus not only were the percentages of time spent on the project higher than officially documented, the absolute number of hours devoted to the project was considerably higher than that of a "normal" 40-hour academic work week.

It is probably unrealistic to assume that the hectic first year schedule of program script writing, visuals preparation, video production, and test development could be continued indefinitely. Although the additional contributions of institutional resources (beyond those proposed) would not bankrupt the university, the physical and intellectual energy pool of those key faculty would likely soon diminish. Fortunately, the necessity for such intense efforts will probably diminish naturally.

Along these same lines, it is also interesting to note that none of these tables report actual personnel hours planned or expended. The assumption usually made is that percentages of professional time or Full Time Equivalents (FTE) are calculated upon a forty-hour work week. In this project, at least for the first full calendar year, this was not the case. The concept of overtime or overload for professional staff in such projects just does not appear to apply.

Other university resources. Table 2 reported the proposed NSF funded and contributed expenditures for the university library, the television production facility, and computing sciences. Documenting actual institutional contributions to the project required interviews with appropriate personnel as well as reviews of actual records of services provided.

The following resource lists with associated costs constitute much of the direct and indirect university investment in the project. Although some contributed resources such as television production assistance, etc. were not carefully documented, an attempt to identify those was also made and reported herein.

A. University Library Microform Media Center (MMC)

In support of the project the library agreed to provide, as needed, appropriate amounts of space and staff as well as funds to replace worn or damaged video cassettes used in connection with the project. The following lists report most of those expenses:

Staff	Position	Cost
Added a Library Assistant I	1977-78 & 1978-79	$ 7,254.00 8,060.00
Added a one-half time Library Assistant I	1977-78 & 1978-79	3,627.00 4,030.00
Supervision of full time and hourly employees by the Head of the MMC, 40% of her time	1977-78 & 1978-79	4,326.40 4,804.80
Casual hourly help, 40% of MMC hourly budget	1977-78 & 1978-79	7,000.00 8,000.00
Overall administration of project: two hours per week	1977-78 & 1978-79	624.00 672.00
Total		$48,398.20

Facilities remodeling in the form of rewiring, expansion of equipment storage space and addition of one counter unit was conducted solely for the project. The total direct cost for this was $5,300.

Personnel Total	$48,398.20
Remodeling Total	5,300.00
TOTAL Library Direct Contribution	$53,698.20

B. University Computing Center (Test Scoring and Evaluation)

In order to continue the development of a comprehensive bank of test items and a subsequent self-paced testing system, University Computing Center Services were used. A conservative estimate (documented expenditures) of computer costs shows $7,500 in contributed services. Although considerable development of this system had been supported prior to the CAUSE project, much additional expansion, revision, and field testing was accomplished within the project.

C. Administrative Data Processing

Costs for data processing services to the project were documented by fund source and amounted to $709.33, $109.00 over what was charged.

D. Television Production

Although NSF resources allocated to the television production facility were intentionally low ($15,000) with a cost estimate of contributed services of over four times that amount ($61,350), in fact the studio reportedly exceeded this contribution by many thousands of dollars. The following list of services and equivalent expenses contains most of those charged and contributed expenses or services.

Studio Time: 220[a] hours @ $400/hr (avg commercial cost) =	$ 88,000
Includes a typical production crew as follows: 2 cameramen 1 director 1 audio 1 video color tuner 1 videotape 1 teleprompter operator 1 projectionist 1 floor manager	
Producer: 220 hours @ $100/hr	22,000
Tape Dubbing: 1300 dubs @ $10	1,300
Film Footage Editor: 35 hours @ $10	3,500
Demonstration Tape Editor: 45 hours (3 tapes) @ $10	4,500
Preproduction Planning by Producer: 100 hrs @ $100 (review scripts, shot sequencing, art integration, electronic character generation)	10,000
Total (est)	$120,300

A cursory review of contributed resources, some of which were officially identified as matching funds, suggests that total university expenses were considerably higher than those listed in the proposal. Personnel time, graduate assistantship allocations, and video production expenses exceeded initial estimates to a considerable extent. This illustrates the project director's strategy of using project resources as leverage to obtain additional university resources for the project. In this way, he was able to expand the benefits of the project to additional students, schools within the university and service support centers such as the library, computing center and the television station.

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[a] Since the completion of the videotapes for the first three courses, an additional 50 hours of studio production time has been donated in order to complete an advanced series of videotapes for use by the department in biology courses and for viewing over regular video channels.

Discussion

In addition to these several rather specific observations related to the cost analysis, these more general comments may be in order. These refer to a) initial startup expenses, b) program continuation, and c) the concept of released time for faculty.

Initial startup expenses. Although any large scale (multiple course) development and implementation project requires considerable resources for planning, curriculum development, production and evaluation, almost all of these are one time, non-recurring expenditures. In this particular circumstance, the large number of students per term and the reasonable course life estimate of five years allows for a commendable allocation of these investment expenses over many course offerings. The much sought after "economy-of-scale" appears to pertain here since there are so many students impacted upon so appropriately for four terms per year for five years with these courses. The incremental cost per student for this development endeavor, if calculated, would thus be acceptably low.

Program continuation. There is ample evidence to suggest that the mere allocation of external and/or internal resources to the creation of a program will not guarantee its continuation once supplemental funding ceases. In this situation, however, NSF funds served as seed money allowing the university to conduct a much larger project which made use of many existing services and available "flexible" resources. Since the courses were being offered prior to receiving external funds, and continuing operation expense appear to be reasonable, additional resources will not likely be required for some time. Revision of outdated videotapes may be the only exception.

The low continuing cost level, along with the strong financial support for the video playback facility in the library (tape replacement, equipment repair, dedicated personnel) all suggest that a real, continuing financial commitment to continue all of the courses has been made by university officials. The many and varied benefits reported in other sections of this report accrue not only to students in the three courses but also to faculty directly involved, other members of the academic department, the library, and the television station.

The concept of release time for faculty. It is useful to consider this project's particular approach to the use and charging of project staff time. One, fairly typical, approach is to release project faculty members for specified percentages of their regular professional time in order to work on a project. An equivalent salary and benefits percentage is then charged to the project budget. Occasionally institutional resources freed up by this process are used to hire replacement faculty or graduate assistants. (Sometimes, however, these released resources are retained by higher level administrators and are not returned to the department or program conducting the funded project.)

In marked contrast to this arrangement, this university chose to release key personnel directly to the project and to hire replacement temporary faculty to teach in their place. Those expenses associated with the temporary instructors (two during the first year) and the temporary assistant professors (two in the second year and one in the third) were charged to the CAUSE project. As can be seen in Table 4, the cost of these replacement salaries and benefits were considerably less than those released salaries and benefits which were part of the university's contribution to the project. In this way, no offset salary monies were removed from the academic program and the direct cost to the project for key project staff was less than if the other approach had been employed.

TRAINING A FACULTY IN COMPUTER APPLICATIONS TO INSTRUCTION: CENTRAL CITY JUNIOR COLLEGE

Site Visitors: Albert Beilby
Terry Coleman
Ramesh Gaonkar
John Penick

Primary Author: Terry Coleman

Preface

Central City Junior College is an institution with a regional reputation for quality instructional programs. The science offerings have been regarded for some years as particularly strong. The faculty and administration pride themselves on a tradition of serving well the needs of the local community. A visitor to the campus becomes aware of a certain dynamism and vigor with which they approach their mission.

The CAUSE project at Central City has focused on the development of faculty skills in instructional computer applications and was targeted for all three science divisions on campus. The growth of faculty involvement in project activities over a three year period has been impressive. This involvement has not been limited to faculty in the science divisions but has included other instructional divisions of the college and other educational institutions in the geographic area.

The names and identities of the people, places, and institutions in this case study were substituted with fictional names in order to protect everyone's privacy. No real names have been used.

Introduction

The eight buildings which comprise the campus of Central City Junior College (CCJC) are located on the eastern edge of the central business district of downtown Central City. Several years ago a movement was afoot to join the mounting exodus from a deteriorating downtown area and move the campus to a more suburban setting. The campus remained where it was, however, a symbolic commitment to the rejuvenation of the downtown area. Highlighted by a bright orange stabile, the work of a famous sculptor, the extensive new construction, ripped-up streets, and renovation of older buildings in the downtown area evidence the dynamism with which urban renewal has been pursued.

On the CCJC campus alone, four new buildings have been constructed within the last decade, a fifth is in the process of construction, one older building is being renovated, and several additional buildings are in the planning stages. The campus exhibits a co-mingling of the old and the new: a multi-storied tannish brick former high school building juxtaposed with white concrete slab and glass monuments to modern architecture.

Populated by approximately 200,000 people, Central City is located almost equidistant (about 150 miles) from two large industrial urban centers. The rapids of the Central River which flows through the center of the city provided the source of energy, and the verdant hardwood forests of the river valley provided the materiel to fuel what was to become the setting for one of the nation's largest furniture manufacturing industries. Though 73 factories still operate in the area, automotive parts and metal products manufacturing have now replaced furniture making as the dominant industries.

Central City Junior College, a two-year institution, was established in 1914. Out of 29 community colleges in the state, CCJC ranks seventh in student population but second in number of faculty (229 full time and 150 part time). The college has always prided itself on a strong liberal arts program and an excellent student transfer track record but has recently been expanding its occupational program offerings. Enrollments have increased 38% since 1970 to a total full-time equated student population approaching 6000 during the 1979-80 academic year. Much of the increase in student population has occurred in the occupational program areas.

CCJC is somewhat unique as a community college in its status as a component of the Central City School District. Technically the college falls under the jurisdiction of the local board of education, but retains a high degree of autonomy, maintaining its own internal administrative structure. As Dr. Raymond Hawkins, President of CCJC, reports, the board of education supports the notion that the college must have a higher level of flexibility than the other school district components.

For some time there has been talk of splitting off entirely from the school district but this does not seem likely in the near future. Pros and cons on the tie to the school district are voiced by administrators and faculty. One liability of the link is the fact that the college's budget is intimately tied to that of the district. Some faculty and administrators point out that the college's needs and priorities differ from the needs of the rest of the district and that these differences are not always clearly understood. Though budget voting issues have had a long history of success in the community, Dr. Hawkins maintains that in a conservative community such as Central City, the budget situation is of necessity always tight. One faculty member voiced the opinion that the college is able to hold its own financially primarily because Dr. Hawkins knows well the politics of the local community and those of the state.

Several faculty and administrators told us that the college's tie to the district provides a very useful "proving ground" for junior college teachers. There appears a widespread belief that many of the better teachers in the district are "rewarded" with positions at the junior college. Some express the concern, however, that such a policy tends to make the college overly parochial in perspective.

The science programs have always been a source of particular pride at CCJC. A 1975 science faculty survey, however, indicated the perceived need to supplement conventional methods of instruction with alternative techniques in order to maintain and improve the quality of instruction. More specifically, the needs identified included:

-utilization of the computer in physics, physical science, chemistry, astronomy, engineering, and mathematics;

-application of calculus and computer usage to the solving of physics and engineering problems;

-use of computer-assisted instruction for students conducting individual research in biology;

-need for students to have computer experience prior to transfer to an upper division college or university;

-use of computer capabilities to assist students with laboratory experiences;

-increase in testing variety (test item banks);

-addition of computer test analysis and scoring; and

-provision of computer inservice training for faculty.

To these ends, two instructional divisions at the college (Physical Sciences and Life Sciences) collaborated in the submission of an unsuccessful CAUSE proposal in 1976. The intent of the proposed project was to provide the resources necessary to update faculty instructional capabilities in the area of computer applications to instruction. Utilizing the comments of the reviewers of the proposal which CCJC requested and obtained from NSF, the project was redesigned and a new proposal was submitted in 1977. The major changes in the project included a reduction in the dollar costs, the addition of a more comprehensive evaluation plan, an increased emphasis on direct student impact, and the addition of Social Sciences as a participating instructional division. A three year grant was awarded to CCJC that year. The grant totalled a $211,000 contribution by NSF and called for an institutional commitment of $150,000.

The primary focus of the project can best be described as faculty development. Specifically, the goals of the project were to:

-acquire and install a small interactive computer system;

-establish a facility to accommodate interactive computing;

-implement an inservice program for faculty to familiarize them with computers as an instructional tool, to acquaint them with instructional computing resources, and to provide them with the opportunity to develop their own instructional computing programs for use within their individual classes; and

-encourage increased communication and articulation with the scientific business sector in the community and with various area colleges and universities.

The Site Visits

In the preparation of this report, we made a total of five two-day visits to the CAUSE project at CCJC over a 12 month period. Two-person site teams conducted three separate visits. A cost analyst made two additional visits. The schedule of visits was as follows:

April 26-27, 1979	John Penick and Terry Coleman
June 25-26, 1979	Albert Beilby (cost analyst)
October 4-5, 1979	Ramesh Gaonkar and Terry Coleman
November 19-20, 1979	Ramesh Gaonkar and Terry Coleman
April 17-18, 1980	Albert Beilby

We relied on observation, interviews, and reviews of project documentation as the primary data collection techniques. Observation included attendance at inservice project classes and classes taught by faculty involved in the project, attendance at CAUSE administrative meetings, and observation of the activities of the CAUSE-related facilities. We interviewed faculty (both CAUSE participating and non-participating), students, and administrators, and we reviewed relevant project reports, promotional materials, file data, and instructional materials (primarily on-line computer programs) emanating from CAUSE-related activities. The primary focus of our visits was on obtaining both a broad understanding of the context, scope, and functioning of the project and a perspective on particular successes and problems. The site visits began two years into the implementation of the project. This afforded us the opportunity to observe project activities when they were well underway.

Implementing the Project

Overview of Project Implementation and Status

The equipment. In 1977, CAUSE monies were used to purchase and install a Digital Equipment Corporation PDP 11T34 computer system, six Hazeltine 1500 terminals and three DEC writer terminals. In 1978, an Ohio Scientific Challenger 3-B microcomputer was installed (50% CAUSE funds, 50% college funds) to supplement the existing system. Other equipment purchased with CAUSE monies included two Ohio Scientific Challenger II microcomputers. In addition, institutional monies and monies from other funding sources have been used to expand the equipment inventory considerably.

The facilities. An organizational unit known as Computer-Based Instruction was set up within the institution to serve as the administrative conduit of project related activities. During the summer of 1977 facilities in the college's learning center building were remodeled to accomodate a combination computer room, office area and resource library and a computer-based instruction laboratory equipped with eight interactive terminals. Three classrooms in the building and several classrooms and laboratories in the Life, Physical and Social Science divisions (located in other buildings) were equipped with telephone or direct wire communications to allow computer access for lecture demonstrations and laboratory work.

In 1978, Computer-Based Instruction was organizationally combined with Data Processing Laboratories (a service agency connected with the college's data processing courses) to form a new organizational unit called the Academic Computing Center (ACC). An expanded computer laboratory work area was established at this time to include a centralized location for terminals, microcomputers, card punch machines, and the college's batch job card reader.

The inservice program. During the fall 1977 semester, an introductory course in computer applications to instruction was established ("The Computer as an Instructional Tool") and has been offered each fall and spring semester since then. Six faculty members (including the chairperson) from each of the three science divisions were enrolled in this initial offering. The participating faculty were chosen by divisional chairpersons on the basis of interest in computer-assisted instruction, training or experience in the use of computer for instructional purposes, and "commitment to self-improvement as demonstrated by personal efforts in professional growth experiences." Beginning in the spring 1978 semester, an advanced seminar entitled, "Development of Computer Related Materials," was established and has been offered each semester since. Participants must complete the introductory course before taking the advanced seminar. A required outcome of each of these courses is that the participants develop a computer program for use within a specific instructional situation.

As an incentive to participation, faculty in the three instructional divisions participating in the CAUSE project were offered three hours' release time to take the introductory course the first semester. Since the first semester, however, only those faculty completing the advanced seminar have been offered this incentive. A cooperative arrangement has been negotiated with several regional university centers whereby faculty completing these courses earn graduate credit. An instructor-of-record from one of these universities administers each of the courses with most of the class sessions being conducted by the project director and guest speakers.

During the first offerings of these two courses, only CCJC science faculty were allowed to register. Since that time, however, faculty from other instructional divisions within the institution, CCJC administrators, and faculty from other area educational institutions (public schools and higher education) have been participants. Figures 2 - 5 illustrate by type of participant the enrollment patterns of these two courses during the period fall 1977 and spring 1980.

Over the course of the six semesters during which the introductory course has been offered, a total of 164 individuals have participated. Of these, 71 have been CCJC faculty with the remainder consisting of faculty from other educational institutions in the area. Among the science divisions at CCJC, approximately 63% of the 24 Physical Science, 82% of the 17 Life Science, and 36% of the 25 Social Science faculty have completed the course. Over the course of five semesters, 46 faculty have completed the advanced seminar with 37 of these being CCJC faculty. Among the science divisions, 50% of the Physical Science, 59% of the Life Science, and 32% of the Social Science faculty have completed the second course. Figures 2 and 4 indicate a declining percentage of science faculty enrollment in the inservice courses (suggesting that a certain "saturation" level has been reached) concomitant with an increasing enrollment of faculty from other instructional divisions at CCJC and from other area educational institutions.

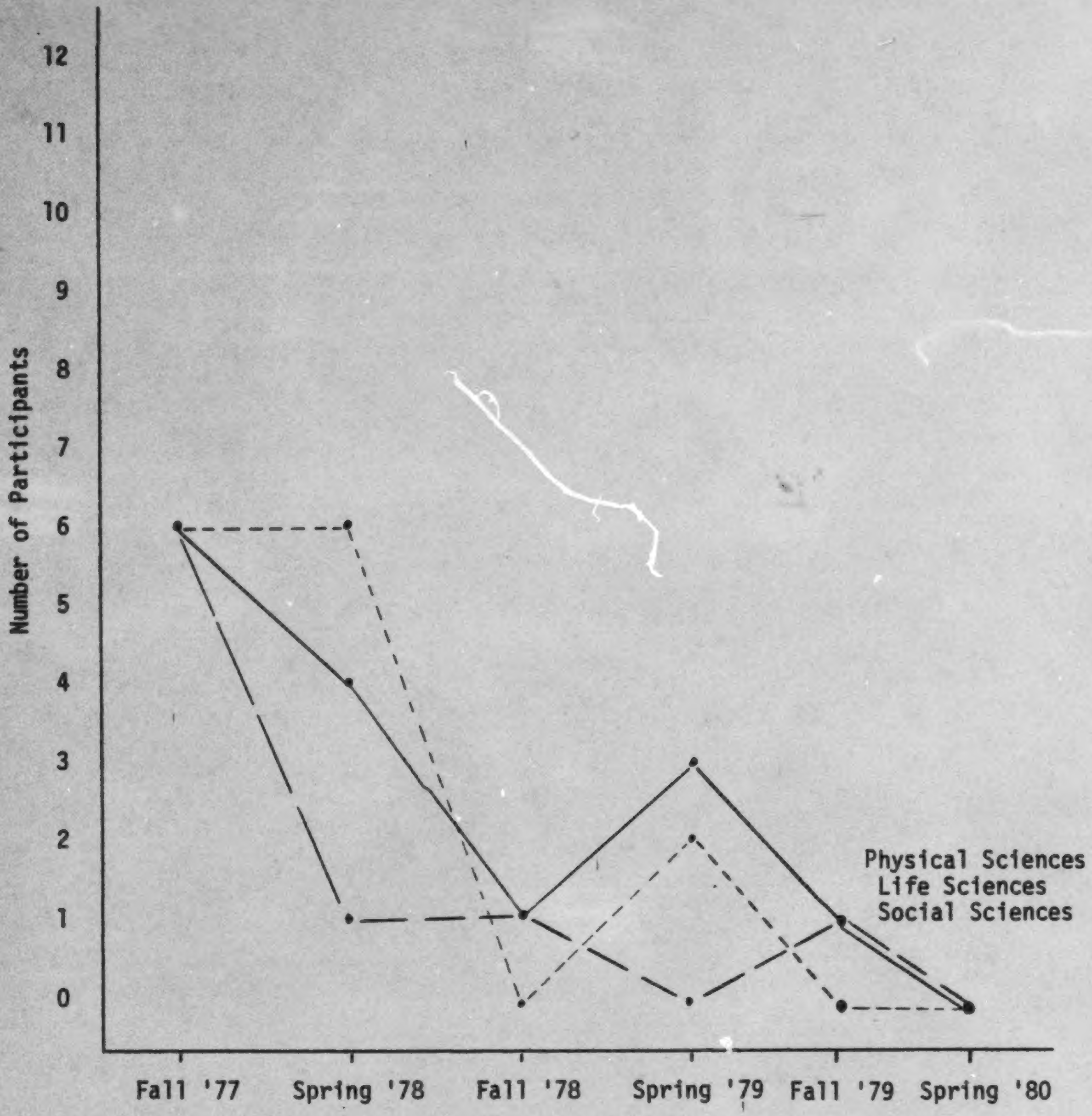

Figure 2

CCJC Science Faculty Participants in the In-service Course:

"The Computer as an Instructional Tool"

Legend

Physical Sciences (N=15) ————————

Life Sciences (N=14) - - - - - - - - - -

Social Sciences (N=9) ———— ————

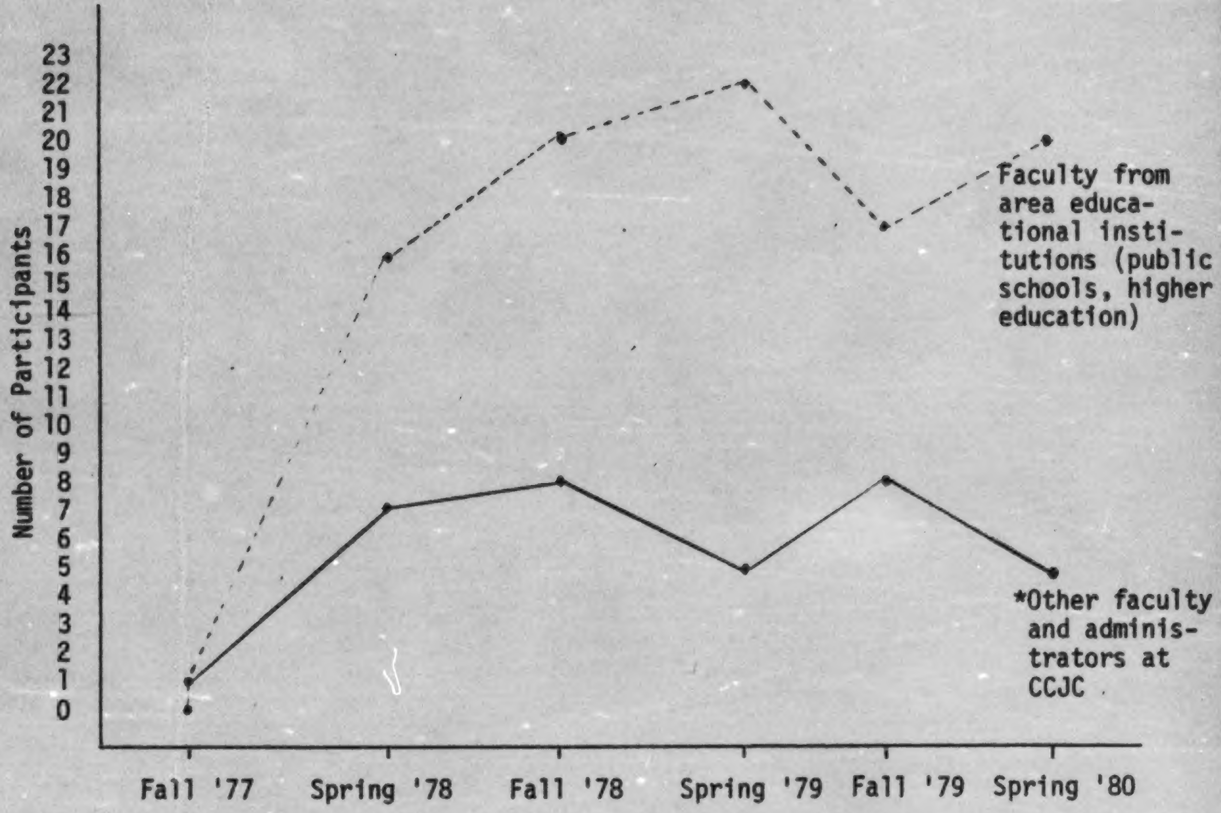

Figure 3

Other Participants in the In-Service Course:

"The Computer as an Instructional Tool"

Legend

Other CCJC Faculty & Administrators (N=33) ________________

Faculty from Other Institutions (N=93) ---------------

*During the spring '79 semester, one data processing student at CCJC took the course and earned college credit at the state university.

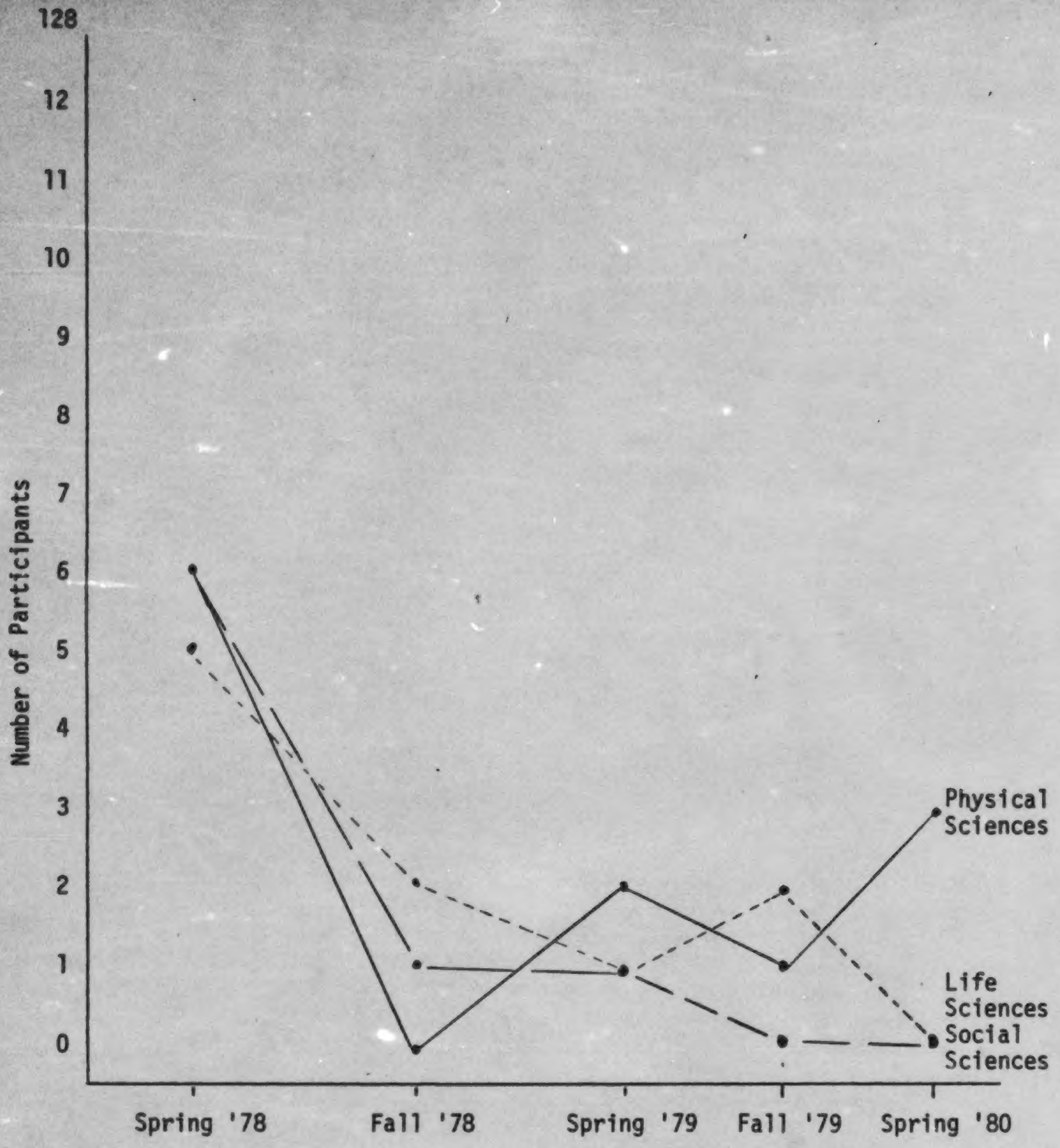

Figure 4

CCJC Science Faculty Participants in the In-service Course:

"Development of Computer-Related Materials for Science Teaching"

Legend

Physical Sciences (N=12) ————————

Life Sciences (N=10) — — — - - - - -

Social Sciences (N=8) ——— ———

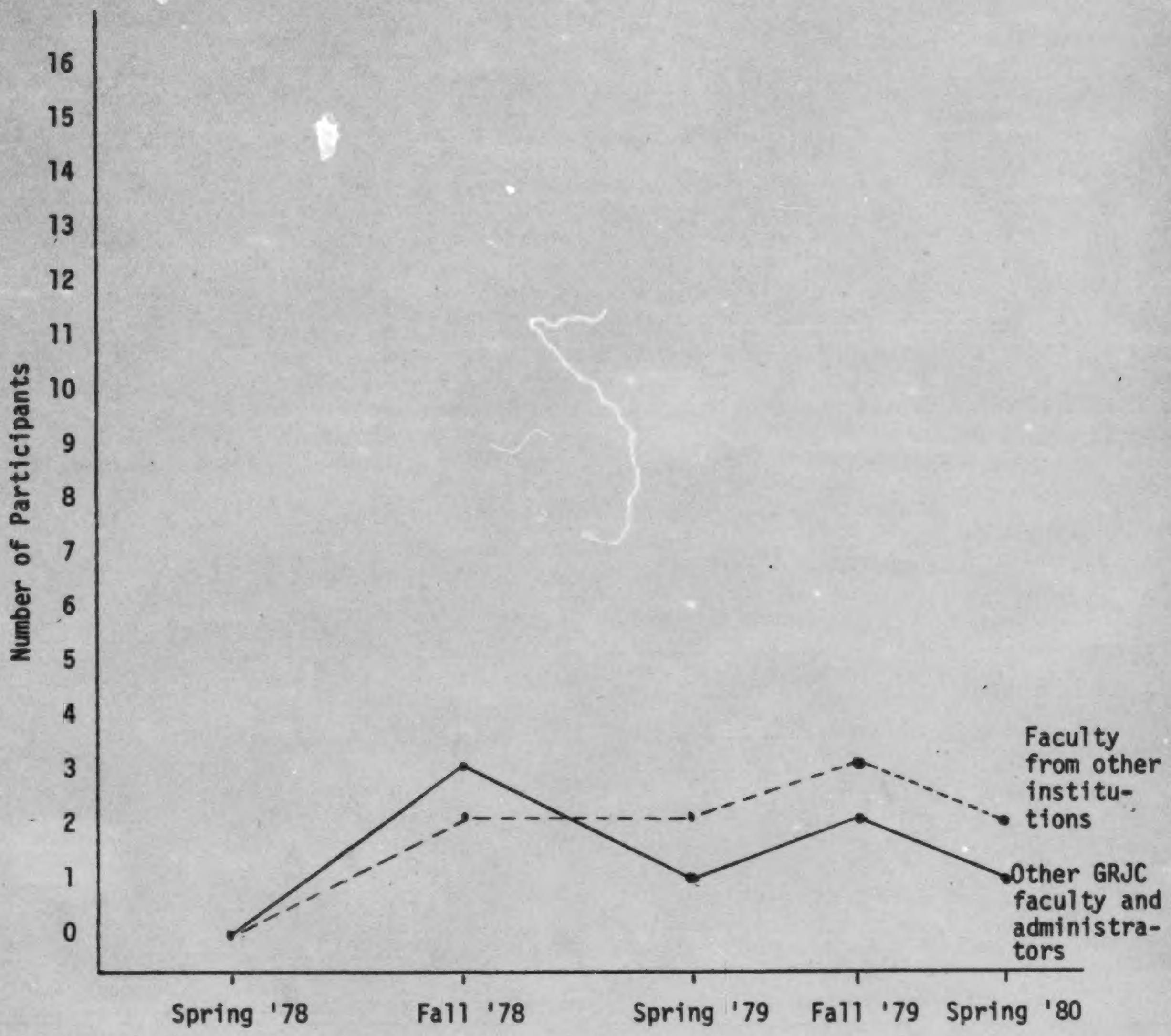

Figure 5

Other Participants in the In-Service Course:

"Development of Computer-Related Materials for Science Teaching"

Legend

Other CCJC Faculty & Administrators (N=7) ————————

Faculty from Other Institutions (N=9) - - - - - - - - - -

Communication/Articulation with Area Industry and Academic Institutions.

Two primary vehicles have been utilized to enhance increased communication and articulation with area industry and academic institutions: the Project Advisory Committee and CCJC's co-sponsorship of various computer-related activities in the community. The Project Advisory Committee consists of approximately 15 representatives (including two CCJC student representatives) from industry and academia who serve on a rotating basis. The committee officially meets two or three times each year but informal communication between CCJC CAUSE project staff and committee members is maintained. The committee's functions have been described by committee members in the following ways:

-to provide updated state-of-the-art technical input;

-to assist in pragmatic policy decisions such as equipment purchases;

-to establish liaisons for the purpose of promoting student internships, graduate placements, and transfer programs;

-to serve as an "idea" group and "sounding board" offering a fresh perspective on issues of interest or concern;

-to promote good public relations between CCJC and the community;

-to serve as a "community educational experience"; and

-to provide a source for project accountability and demonstration of impact.

Since the inception of the CAUSE project, CCJC has also hosted a state-wide conference on the use of computers in education (1978) and a regional microcomputer fair (1978), and has joined with three other area colleges in the submission of a consortium CAUSE proposal (1980). In the Spring of 1978, the project ran a display/performance exhibition at a shopping mall in the Central City area using terminals connected to the college's minicomputer to demonstrate instructional computer programs which CCJC faculty and students had developed. Annually, the project provides a computer display during the regional junior high school mathematics competition.

The People of the Project

While numbers of participants and listings of events provide an outline sketch of the nature of CCJC's CAUSE project, a more revealing perspective can be gained by an understanding of the people who shape and participate in the events.

The project director. Rick Haig shares an office area with a secretary, two data processing instructors, several bookcases and files, an assortment of computer-related equipment, including the PDP 11T34 and Challenger 3 computers, and a frequent stream of faculty and student visitors. The pace of the place is busy, reflecting Rick's work schedule. The office is located on the second floor of the new learning resources building which houses the library, language learning laboratories, the media center, and an assortment of classrooms and office space. Just down the hall is the Academic Computing Center Laboratory where students utilize on-line instructional programs and where several data processing courses are taught.

Rick has served as director of the project on a full-time basis since the CAUSE grant was awarded in 1977. For more than ten years prior, Rick had worked for the Central City School District in various positions relating to data processing and computer services. These positions included instructor of data processing and computer math at the junior college, systems analyst, and assistant director for the district's Data Services Department. During the year prior to the inception of the CAUSE project, Rick was on special assignment for Data Services researching how instruction in the district could best be supported by computer resources. Through these experiences, Rick brought to his job as project director a good working knowledge of the people, policies, and politics of the district and particularly those of the junior college as they related to computing services.

Rick describes himself as a "quasi-administrator, quasi-faculty member," directing the Academic Computing Center but also working with students to some extent, particularly those who work as assistants in the center. Rick foresees a need in the future for much greater expansion of the college's computing capabilities. Prior to CAUSE, virtually no college faculty person (except the Data Processing/Computer Science faculty) was using the computer as a learning tool in their classes. According to Rick, this was due to four factors: the lack of faculty computer training, inappropriate computer equipment for instruction and learning purposes, low priority for instructional computing on the district's IBM 370 computing system, and the lack of a resource person to work with faculty. Because instructional applications have low priority and the district's computing system is virtually overutilized and because the college's computer science/data processing curriculum increasingly demands more computing service, Rick suspects that the college and the district will need to develop totally separate computer capabilities in the future. Demand for computer time by faculty and students is beginning to outstrip available supply.

Though the pace of Rick's work is hectic, his approach to project tasks is straightforward and "low key" in style. He exhibits an evident enthusiasm for the project. Among the major impacts, Rick cites the broad scope of faculty participation and the benefits to students, both in terms of the computer-aided instructional units faculty have developed and in terms of increased exposure to computer technology. The students who have served as assistants in the ACC in particular, he believes, have benefited. These students have had the opportunity to enhance their computing skills by working with individual faculty on instructional programming projects.

Numerous unsolicited comments made to us about Rick during our visits indicate that he is highly respected by both administrators and faculty at CCJC for both his managerial abilities and personal characteristics. Most often cited were his enthusiasm, dedication, attention to detail, involvement in community activities, and hard work. As one faculty member stated, "Rick works so hard that everyone feels guilty if they don't work equally as hard." These qualities in its director, combined with a high level of administrative support for project activities, undoubtedly (in our opinion) were key factors in the successful proliferation of interest and participation in the project among faculty across the institution.

The Project Council. The Project Council was set up to provide decision-making and policy direction for project functioning. It has proved to be an important ingredient in effective implementation since it promotes active participation by and communication among key administrative personnel: the chairpersons of each of the three instructional divisions participating in the project, the Dean of Arts and Sciences, and the project director. During the first years of the project, this group met often, on a monthly or biweekly basis. As project activities became more self-sustaining and institutionalized within the daily functioning of the institution, the meetings became less frequent and are now called primarily on an "as needed" basis.

Herbert Dorr, chairperson of the Physical Sciences Division, was one of the prime movers in initiating the submission of a proposal to CAUSE. He had heard about CAUSE while serving as CCJC's representative to a NSF regional informational conference in 1976 when the CAUSE program was for the first time soliciting proposals.

Herb Dorr has taught chemistry at CCJC for almost 20 years; for 17 of these years he has been chairperson of Physical Sciences. When we spoke with him during the spring 1979 semester, he estimated that about seven of the 24 instructors in his division were using the computer as an instructional tool in their classes on a regular basis. Some of these were reported to be using the computer on a weekly basis, while others were using it perhaps once or twice a semester, or once every three or four weeks. He related that for the most part, these faculty members were using the computer either to present content in lab courses, for testing purposes, or for student drill purposes.

When we asked him what problems the project had experienced, he replied that they were running into some difficulty with over-utilization of disk space. Sometimes there were complaints from faculty that space and/or programs were not available when needed since they were being used by other faculty. He also touched on the topic of release time incentives. He thought that a problem had stemmed from the perception on the part of some faculty (particularly in the Social Science

Division) that there were inequities involved in the process they had utilized during the first inservice offering for selecting faculty participants.

Herb stated that from his perspective, there have been two primary impacts of the project. The first has to do with the increased emphasis the project has brought at CCJC on the concept of inservice education and faculty development. The second (and probably the more important impact from his perspective) has been the increased level of interdivision cooperation and communication. He feels that prior to CAUSE there was very little communication among faculty across the three science divisions. The CAUSE project, from his viewpoint, has provided a strong catalyst to faculty from different divisions for working together, and he hoped that it might become a model for increased cooperation among divisions campus-wide.

Harold Marlowe has taught biology and botany and has chaired the Life Science Division for nearly twenty years. He, like Herb Dorr, has been actively involved in the project since the first (unsuccessful) CAUSE proposal. Several faculty (both within and outside the division) described to us the Life Science Division as a relatively close-knit group. Harold believes that the faculty in his division are closer as a result of the project. A large proportion of the faculty in his division have participated in the project; as a consequence, his division has accumulated a sizeable number of computer programs, many of which are shared among faculty members. These programs are primarily tutorials, remedials, and review exercises, all of which are optional for student use.

Harold expressed to us a good deal of excitement about the project. He is quite confident that the project will be able to continue adequately after the termination of the grant monies because of the commitment on the part of the administration which the project has generated. He himself has purchased a terminal out of his division's capital outlay budget and has written several proposals to get micro-computers. He also pointed out that some release time, not associated with the grant, is available through central administration.

Joseph Bowen, historian, and chairperson of the Social Sciences Division for the past sixteen years, was not involved with the initial CAUSE proposal. He was asked to participate in the second proposal when it became apparent at CCJC that the social sciences were included within NSF's guidelines for the CAUSE program.

Joe reported that he was not initially very supportive of the project since he did not see how computer applications would fit with social science instruction. After attending the two inservice courses and after developing several instructional computer programs of his own, however, he became very excited about the possibilities. He can now be classified as a very strong supporter, having allocated (as have the other two chairpersons) capital outlay funds to purchase computer equipment. His enthusiasm apparently has not spread to the rest of the social science faculty, however. Only nine out of 25 faculty in his division have chosen to participate in the inservice program.

Joe uses the computer primarily as a demonstration aid to show students things that cannot be seen in lecture very easily. For example, one of his programs illustrates the interactive relationship of energy supply and demand. He believes very definitely that the project will continue after CAUSE funding has ended because he sees strong central administrative support as well as the support of the three division heads. He does feel that there might be a reduced level of staff funding but he does not see this as seriously detrimental to the overall goals of the project.

Dr. Clarence Sauro, Dean of Arts and Sciences, is central administration's representative to the Project Council. A former English instructor, he expresses strong support for the project. While reporting some dismay that many of the faculty-developed programs are not as creative as they might be, he stated that he is extremely impressed and delighted by the extent of faculty involvement which the project has generated. He is eager to obtain a terminal in his own office to be used for record-keeping, management, and for things like holding the college catalog. None of these were ideas he had prior to the project.

Project Analyst

Dr. Keith Zeno, Research Scientist at a center for research on learning and teaching at a nearby university center and well known for his work in the area of innovations in education through the use of computers, has served a dual function in the CCJC CAUSE project. Keith has served both as technical consultant to the project, acting as the instructor-of-record for the inservice courses, and also as project evaluator.

He believes that CCJC is unique as a community college for several reasons. Primary among these reasons, he stated, is the fact that the school has had a long tradition of community involvement and support.

This involvement and support partly stem, he believes, from the fact that the college was established within the public school system and has striven to develop and maintain high visibility in the community as an institution with a strong academic program. He related that the college has a strong transfer program for students which is supported by articulation with various four-year colleges and universities throughout the state.

Keith feels that the CAUSE project has had institutional impact in a number of ways. It has strengthened the college's links to the community, has increased the visibility of computers as an instructional tool among higher level administrators at the institution, and has provided a vehicle for increased faculty professional development. As evidence of institutional support, Keith reported that the institution has come forth with additional monies for the project, monies which are in excess of the institutional commitment in the original CUASE proposal.

As reasons for the project's success, he cited Rick Haig's competence as project director, the involvement of other key individuals in the administration and coordination of project activities, and the fact that the project involved local efforts to deal with the local situation, thus avoiding the sometimes negative impact of infusing approaches and materials developed outside the local context. Since most of the computing programs have been developed locally, he thinks a sense of "ownership" has developed. He cited the problems many times involved in adapting other programs (commercially produced) to the needs and constraints of individual situations.

Rick Haig, he thinks, is ideal as director, not only because of his sustained and dedicated work efforts, but also because of the respect which he has generated through participation in a variety of community affairs. Also key to the success of the project, he thinks has been the "esprit de corps" generated by the participation of Project Council members in project activities, including their participation as students in the inservice courses.

As project evaluator, Keith describes his role as that of advisor guiding evaluation efforts, meeting with project staff, faculty, and administrators, and making recommendations as necessary based on his observations. He defined evaluation in the project as providing both descriptive information for reports to various audiences (Project Council, Advisory Committee, institutional administrators, annual reports to NSF) and information which helps inform decision-making. He described his role in the latter function as one of sensitizing decision-makers to various needs, available resources, and problems of the project and thus promoting their sense of ownership toward the project and their commitment to project activities. He believes that anecdotal data are very important since they provide a sense of reality and honesty not always evident in statistical data.

The faculty view. A large percentage of the faculty at CCJC are tenured. The traditional ranks of assistant, associate, and full professor do not exist and all faculty hold the title, instructor. Consequently, the traditional promotion reward structure does not exist. Monetary incentives do exist, however, with provisions for salary increases tied to completion of graduate courses. Faculty members are not expected to do research and publish (although some do); their primary responsibility is teaching. The required teaching load for full time faculty is 15 contact hours per semester. It is traditional for most faculty to teach several additional overload hours.

During the first offering of the introductory inservice course, those faculty in the three science divisions who participated were awarded three hours release time (taken by most faculty as overload hours). It became apparent, however, that to follow this pattern throughout the remainder of the project would mean an overextension of project funds. The Project Council, therefore, decided to change the policy on faculty incentives such that only those who completed both inservice courses would receive the release time incentives.

Over the course of 12 months, the site visitors met with numerous faculty members who were participating in project activities, both within the science divisions and in other instructional divisions within the institution. Faculty who had chosen not to participate were also interviewed. In this section of the report, the views of a sampling of those faculty interviewed are presented. Those faculty chosen for inclusion in this section are considered by us to be relatively representative of the range of opinion expressed by those faculty interviewed. No estimation of the degree to which those interviewed are representative of the larger population of all science faculty or all faculty at CCJC, however, can be accurately made.

Al Paone, psychology instructor, was among the original five faculty members chosen from Scoial Sciences to participate during the first inservice semester. When asked why he was selected he replied that "only five social science faculty had originally applied." He believes that the social science faculty did not initially see the relevance of computer-assisted instruction to their areas. Now that the project is in full operation and is very successful, according to Al, more social science faculty have become interested.

Al has developed 16 computer-assisted programs for use in his general psychology classes. Students first complete a reading assignment and then utilize a computer program for question and answer review. A survey which he conducted in 1979 indicated that 70% of students enrolled in general psychology classes had used one or more of the computer programs. When asked why the programs are not mandatory in courses, Al replied that there are not enough terminals and, if the computer-assisted exercises were mandatory, then he would have to figure out a way to evaluate students' work with them. Most of the programs he has developed are linear question-and-answer review programs while some border on simulation activities. He does not believe there is enough storage space to create extensive branching programs or true interactive simulations.

As for the future, he thinks the program might stagnate. He explained that the junior college is part of the K-14 school district which does not view the junior college as a favorite. Al is worried that the college may not get adequate monies to maintain the system, much less upgrade it.

Jim Macanak, who teaches physics, believes that the CAUSE project at CCJC is working far better than similar programs he has seen at other institutions. In his estimation, this is primarily due to the extent of faculty involvement. This involvement, according to him, is because the quality of the first fifteen faculty members in the course was exceptionally high--they were all workers, enthusiastic, and able to communicate the good of the program to their colleagues.

Jim uses the program to supplement his teaching and has developed a number of programs including one to help teach students how to identify constellations and another to help him grade tests. He has been interested enough to attend at least two national meetings dealing with computer-assisted instruction and he presented a paper at one of them. Jim was very eager to demonstrate to us the terminal which was purchased with divisional capital outlay monies and which is installed in his laboratory. He has taken both of the two inservice courses but feels that they were too much alike and more oriented toward learning about computers rather than how to use them. He expressed dismay at his own lack of programming ability and would like to rectify that. He does not feel very confident about continued support from the administration after the CAUSE money is gone.

John Lussier is a geographer in the Social Science Division. He originally had considered taking the introductory inservice course during the first offering. Instead, he elected to wait for the second offering. He didn't take it the second time around because of what he perceived to be an inequity in the use of the release time incentive. Faculty taking the introductory course the first semester were awarded overload hours, whereas those who chose to participate after the first semester had to take both courses to obtain the incentive. He said it was not a financial matter but a matter of principle which stopped him from taking the course. He also feels that there was a conflict of interest involved in the fact that the three division chairmen were members of the Project Council and also members of the first group to take the course.

John noted the low level of involvement on the part of the social science faculty in the project; he does not feel that the programs that have been generated are that useful, describing them as "gimmicks", and "hucksterism". He believes that they are programmed instruction at best and that the project is merely a fad which will die out as soon as the grant has terminated. When the site team suggested to him that simulations might be a more creative approach to the use of the computer, he replied that his students were not ready for simulations, that this was only a junior college, and that he had enough problems teaching them the facts they needed to go on to a four-year school.

Harry Morgan has been teaching physical geography at CCJC for 15 years. At the beginning of each semester, Harry brings a computer terminal into class and demonstrates its use for the students. He feels that this helps lower the frustration level which some students experience in using a computer for the first time.

Over a two and one half year period he has developed over 50 computer programs for use in his classes. The programs deal with a particular class topic and take the form of a series of structured questions to which the student must respond. He has also developed several programs which are used by students as pre-exam self-diagnostic exercises. These programs keep track of the number of correct and incorrect responses a student makes and provide the student with a "diagnosis" as to how ready s/he is to take the exam. Harry also uses computer programs developed elsewhere; he finds that through the use of computer simulation exercises, he is able to teach concepts in his classes which he had not been able to teach before through lecture or demonstration.

Harry stated that most of his programs utilize the same technique in standard written workbooks but that they lack the tedium associated with workbooks. He believes that there is a dynamic quality to computers, much like television, which intrigues students. He does admit, however, that his son tells him the computer is too impersonal as an instructional tool, so he tries to use "gimmicks" in his programs to lessen the formality and make them more personal to the students. He has an intuitive hunch that the students who benefit most are those who would normally get C or D grades. He thinks his programs provide them with the extra assistance they need to get higher grades. He reported that some of his students tell him they sometimes have trouble accessing the programs because the Academic Computing Laboratory is too busy.

At first, Harry reported, he was not too excited about using the computer for instructional purposes, but once his chairperson "twisted his arm" to get involved, he found himself extremely enthusiastic. He is not sure why the excitement has not caught on much in his division (Social Sciences) but thinks it has a lot to do with overcoming ingrained tradition. As to the incentives which keep him actively working with the computer, he states that it is the excitement and enjoyment he gets out of it (his "kicks") and the fact that it is helping him do a better job.

John Bednick and Mike Hannahan run CCJC Educational Development Center, a tutoring service available for students seeking assistance with their course work. The center matches these students with other students qualified to tutor. Approximately 10% of the student population utilize the center's services. Both men have taken the introductory course and are enthused about the potential which computers have for the operation of their center. They feel positive enough that they purchased two terminals with their capital outlay funds. There, terminals are used by both students being tutored and other "drop-in" students to access instructional programs for specific courses. John and Mike have designed one program which matches tutors with clients, a process that formerly was done by hand which was very time-consuming; they appeared anxious to develop more, including automation of their record-keeping on the computer.

Hank Lustig who teaches music at CCJC has taken the introductory inservice course and has developed 18 programs which drill students on scales and chords. He thinks that the computer is "disarming" as an instructional tool and that students get a "buzz" out of it. To keep the students interested he tries to keep his programs "funky" by maintaining a level of humor in responses given to students.

Hank admits that his course in music theory contains a lot of "drudgery" and that the computer mitigates a lot of that drudgery both for himself and for his students. He thinks that anything which requires drill, like much of his course, should be computerized since it helps to alleviate the boredom.

Gilbert Urschel has been an instructor in Life Sciences for 13 years. He has not taken either of the inservice courses and is skeptical of the worth of the project relative to its cost, especially given the amount of time faculty members invest in it. He thinks that the tremendous amount of time devoted to developing the computer programs could be better used developing audiovisual materials and that more monies should be devoted to improving AV equipment accessibility; he cited having to hand-carry an overhead projector from another part of campus to use in his class.

Although interested in learning more about the computer, Gilbert thinks there has been too much administrative pressure on faculty to get involved. He has attended a few meetings of one of the inservice courses but reported that he did not understand much of what was going on and has heard from other faculty that there is a lack of organization to the courses.

Pam Dennis uses three programs on the topic of titration in her general chemistry lab course. She describes the programs as "more jazzed up" than drill or tutorial exercises, utilizing graphics and constant feedback to the student. She also has developed three test item banks.

Pam believes that students are "blunted" by paper explanations of topics such as titration and that the computer is able to provide an explanation which is visual and more concrete. She does not see that the "return" on the time of developing tutorial programs would be that high and feels that faculty should now be developing more sophisticated applications.

Terry Butcher has developed a tutorial program for use in his Biology 101 course and has also developed several computational programs which he uses for genetics calculation. Since the Life Sciences Division only has one terminal and the Academic Computing Laboratory is located across campus, he has adapted his programs for use on microcomputers. He believes that the microcomputers will be the wave of the future in education because of their flexibility. When we spoke with him he had not yet implemented his tutorial in class and so he was not sure what the reaction of his students would be.

Donald Ronan, an instructor in the Life Sciences Division, described to us a series of programs which had been cooperatively developed by faculty in his division. For each of the introductory courses in biology, botany, and zoology, approximately ten tutorial programs (each consisting of about 25-35 questions) are available to students on-line. He estimated that these programs cover most of the content areas of these courses.

Don believes that the extensive interest and participation first evidenced in the project is waning. One of the reasons he cited is that faculty have limited time to devote to programming. Although many of the student assistants who work for the ACC are good programmers and help considerably, there is a large turnover each year and therefore the service is not consistent. He also thinks that there might be some disappointment on the part of faculty with what the computer can do with only limited investments of time and expertise. He thinks that one or two full-time professional programmers on staff at the ACC would help considerably.

We informally approached several faculty in the student cafeteria during one of our visits. A librarian did not know too much about the CAUSE project, but he did indicate that student usage of computer periodicals had increased dramatically and that students talked about computer-related things in the library frequently. A faculty member from the

Technology Division made positive comments about the CAUSE project, but stated that he himself had not been involved with the inservice courses. He cited lack of time as the problem. A biology instructor echoed the problem of lack of time. She also thought that the nature of the content she teaches (anatomy) did not lend itself to computer-assisted instruction. She thought the CAUSE project was a good program, but she personally does not like machines, although her husband (who also teaches at CCJC) was involved in the project and had even purchased a microcomputer for use at home. An instructor in the Life Sciences Division, a well known nature photographer who has had several photographs used as covers of national magazines, took the first course but not the second. He said he is in favor of the CAUSE program and would ultimately like to get more involved himself. He, too, cited the lack of time as the reason for not getting more involved.

The student perspective. One of us visited three classes conducted by faculty members who were using the computer as an instructional aid. Approximately 50% of the students in each of these classes reported using the computer to some extent for review or tutorial. Reasons cited for the use and non-use of the computer included the following:

- "It is very useful for review materials; it provides instant feedback."
- "It prepares me to take tests."
- "I would rather read a book at home and study for tests. The computer does not give me anything which I cannot find in my workbook or textbook."
- "It provides personalized responses."
- "I am afraid of the computer."

-"I like the interactive aspect."

-"The number of computer terminals is very limited and not available when we need them."

-"I have outside responsibilities (job/family) and just cannot afford the time."

-"I do not like reading textbooks; this is better than reading the book."

-"The programs are rather trivial and not useful to take tests."

We questioned several students working at terminals in the Academic Computing Laboratory. One, a students in a developmental math class, said that he found working with the computer "fun" and "challenging", much better than working with math problems in a book. Since he is a full-time employee of a shipping company, he reported that he did not have much time to devote to studying for the two courses he is taking. With what time he did have, however, he would prefer to use the computer. Before taking the math course he never had used a computer but now thinks he might like to get into it as a field.

Another student was on-line with a program which was giving mock test questions in preparation for an upcoming class exam. She said that she likes to use the computer programs even though they did not really have anything in them which could not be found by reading the text or listening in class. She felt the computer helped keep her organized however.

During these interviews, the computer laboratory was busy. Only one terminal was available; all the microcomputers were being used. One engineering student was working with an APPLE microcomputer. The program he was creating involved the generation of musical scales and chords, an area the student reported as his hobby. Several other students were watching and talking enthusiastically about the capabilities of the APPLE. Randy Manson, a CCJC instructor, came in later to work on the APPLE. He's been awarded a grant by the Office of Education to develop computer programs to teach metrics to elementary and high school students and adults. The noise level in the room increased considerably when a data processing class convened and began operating the bank of key punch machines.

We interviewed several students who worked as assistants in the lab. Since the college is a two-year institution, the turnover of students has presented a problem in that the time required for the training of assistants is sometimes greater than the time of useful service. Rick Haig has tried to alleviate this problem by getting qualified high school students to begin working in the center before they enroll at the junior college.

Pete Loop began working at the center when he was in eleventh grade; he had taken a computer course which Rich Haig taught and got involved through him. Pete reports that some of the assistants are recommended for the job by high school teachers or become known at the center for their interest by "hanging around a lot" and demonstrating good programming skills. He estimated that during any given semester there were probably six to ten student assistants working with at least one assistant on duty at all times. He said that about half the time on duty is spent helping students who come in to work on programs; the other half of the time is spent monitoring and fixing programs and helping faculty with programming problems.

Scott Plevel also began working at the center on an internship while still in high school. He believes that the computer is a help for students since it provides an active form of studying and makes the content more interesting. He reported that some students are disappointed that there are not more programs available. Scott also reported that quite a few faculty members come in to work on their programs at night.

Project Outcomes

Short Term Impact

At a very general level of observation, there have been several major impacts of the CAUSE project at CCJC. Most obvious is the very extensive faculty participation in the inservice program, both within the science divisions and across other divisions in the college. As of the spring 1980 semester, at least 70 faculty from the institution had taken at least one of the inservice courses and evidence exists through multiple observations and reportings that at least a modest percentage of these faculty are continuing to utilize the computer as an instructional tool in their classes. Not to be neglected are those individuals external to the junior college, mostly from local public school districts, who have availed themselves of the opportunity to take at least one of the two courses. Since we interviewed none of these individuals, it is not possible to estimate the degree to which these individuals have applied their knowledge and skills in computer applications to their classrooms.

The proliferation of computer equipment (e.g., microprocessors, terminals) acquired through institutional funds which are incremental to those originally committed to the CAUSE project is evidence of an increading interest in and commitment to the notion of instructional computer applications. In addition, several grants have been awarded to the college by governmental and private foundation funding agencies for projects related to the use of computers for instructional purposes. It should be noted that this proliferation of equipment has not been restricted to the science divisions. The extent to which the increased interest in computers is directly attributable to the activities of the CAUSE project is debatable, but it is our opinion that the project served as a key catalytic factor.

There is also evidence to suggest that the project has been a catalyst for increased interdisciplinary communication and articulation. Several faculty and administrators we interviewed reported that they view this as the most important impact of the project. Through the inservice program, faculty from various disciplines attend common classes and the project director makes it a point to have faculty who had previously completed a course come to new classes to report on their software development projects. A few projects by their nature are interdisciplinary. At least two instructors are in the process of developing general testing and grading procedures which are generalizable to all content areas. One physical science faculty member has been granted release time to work directly with faculty on developing their programs; another faculty member has performed a similar function without release time.

The project has probably also led to increased stature and visibility and more efficient operation of computer services on campus. With the creation of the ACC by the integration of two previously separate campus service agencies (Computer Based Instruction and Data Processing Laboratories), integrative planning for future computer-related needs and priorities can take place. The ACC is under the direct jurisdiction of the Dean for Academic Services. This is likely to give it more clout in negotiating matters relating to the sharing of computer services with the school district.

The impact which the project has had directly on student learning is not clearly determinable. One or two independent surveys conducted by individual faculty members indicate positive student attitudes toward the use of computers in instruction, but no serious attempts have been made to this point in determining what kind of effect, if any, the increased utilization of computers in the classroom is having on student learning. Neither are there data readily available to determine the extent of student use of the available programs.

Some concern has been expressed that the majority of the instructional applications of the computer (e.g., tutorials, question and answer review exercises, item banks) do not really capitalize on the unique capabilities for instruction which the computer offers. It is our opinion, however, that most of whatever positive impacts on student learning which do occur are probably due as much to the result of the increased attention to and analysis of instructional processes and content as they are to the fact that the computer is being utilized as the instructional medium. Many of the faculty interviewed reported that writing instructional programs forced them to really analyze what they were teaching and how. This is not to deny that in some cases concepts are being effectively taught through the use of the computer which otherwise would have been difficult or impossible to teach. Neither is it to deny that as the programming sophistication of the faculty matures, additional applications which capitalize more broadly on the capabilities of the computer will become more predominant.

Long Range Impact

The future viability of CCJC's project is likely to depend largely on two factors: continued faculty interest and commitment and continued institutional support. From discussions with faculty involved in the project, we believe it quite likely that at least some of the faculty presently using the computer as an instructional tool will remain for some time highly committed to its use and to the expansion of its application.

The pattern of enrollments over time in the inservice programs (see Figures 2 and 4) indicates a leveling off of enrollments among CCJC faculty, especially among the science faculty. Whether this pattern indicates a declining interest on the part of faculty at CCJC or merely indicates that a certain saturation point has been reached remains to be seen. It would be unfortunate if faculty enthusiasm were dampened due to too much faculty participation at the start and a resultant overutilization of resources. As some faculty have mentioned, frustration is beginning to develop over a lack of sufficient disk space and programming assistance.

The likelihood of continued institutional support for the project after the CAUSE funding period ends appears high, indicated by both strong verbal testimonials by administrators and by what we perceived to be a sincere commitment to allocate necessary funds. An example of this commitment is the president's suggestion that the proposed budget for the ACC be increased to allow for additional programming assistance to be made available to faculty. Various attempts are presently underway at both the individual faculty and institutional levels to locate and obtain additional external funds.

Reflections on CCJC's CAUSE Project as a Successful Diffusion Effort

A visitor to the CAUSE project at CCJC cannot help but be impressed with the rate and extent of faculty involvement. In this brief concluding section of the report, several conjectures concerning the key factors which might have supported this widespread proliferation are offered:

1. The use of computers for instructional purposes was perceived by faculty to have value prior to the inception of the project. In a pre-project survey of science faculty the use of computers was among those items listed as having high priority.
2. The project director is highly respected across campus and is known to be an individual who works hard and can be trusted. This undoubtedly provided the project with a measure of perceived legitimacy.
3. The involvement of several key administrators, (at both the divisional and dean levels) in decision-making for the project provided official sanction and additional legitimacy. Their active involvement (as members of the Project Council) also provided the project with immediate administrative support. This is particularly important in a project such as this which crosses organizational structures within the institution.

4. Tangible incentives were provided to faculty. Science faculty members not only were able to earn three hours' release time for participating in the inservice program but were also offered the opportunity to earn graduate credit which in turn impacted salary stuctures. It should be noted, however, that there has been some negative impact associated with the use of faculty rewards. Due to a miscalculation on the part of project administration concerning how release time incentives would be offered during the first semester of the inservice program, several faculty have become mistrustful and have actively resisted participation.

5. The faculty members who participated in the first run of the inservice program appear to have been chosen on the basis of the likelihood that they would actively become involved and committed to the project. These individuals have been described by other faculty members as opinion leaders, concerned teachers, and dedicated workers. They have likely served as role models and effective channels of communication to the rest of their faculty peer group.

Project Costs

This section of the report which was written by the cost analyst, Albert Beilby, presents an analysis of the resources committed to the project. The costs of the resources are assigned to specific project activities according to their use. Procedures employed in data collection and analysis are detailed below followed by tables of results. The results are then discussed in terms of project impact and are related to findings in the preceding section.

Procedure

I visited the project site on June 25 and 26, 1979 and on April 18, 1980. Most data were collected during those visits. Additional data were obtained by a brief questionnaire.

Before visiting the site, I reviewed the project proposal and discussed the project briefly with one member of the case study team. I then wrote the project director outlining the purpose of the visit and describing the cost categories which I perceived would be useful in describing the project. During the first hours of the initial visit, the project director and I agreed on the following cost centers:

1. Inservice Training - in which CCJC faculty are instructed in instructional uses of the project's computer.
2. Instructional Development - in which CCJC faculty develop computer-based instructional modules.
3. Dissemination - in which faculty are involved in meetings and conferences for the purpose of disseminating information about the project.
4. Administration - in which project staff develop policy, administer the project and provide assistance to faculty.

Subsequently, I adopted a fifth center, Release Time, to accommodate the sizable direct payments to faculty who took in-service training courses and to those who replaced the faculty to take the courses. This cost center is employed in order to give a clearer picture of in-service training costs.

Costs are also expressed in terms of content areas and are reported by time periods. The content areas reflect the divisions of the college involved in the project:

1. Social Sciences
2. Life Sciences
3. Physical Sciences

The academic periods covered are the summers of 1977, 1978, and 1979, and the academic years 1977/78, 1978/79 and 1979/80. The costs for summer periods are reported with the subsequent academic year costs. The use of academic periods permits the examination of effort over time in various activities by the instructional divisions.

This report focuses on personnel costs since experience has shown this is the type of cost subject to most deviation from planned costs due to fluctuation in effort. Non-personnel costs frequently deviate slightly in terms of specific objects (e.g., the brand or model of equipment), but much less so in terms of amount, purpose, or function. The non-personnel costs are treated in summary tables in this report.

This report was compiled primarily from interviews. Faculty and staff were asked to estimate the percent of time, or the number of person days, they devoted to CAUSE activities for each academic period.

Some faculty and staff were not available for interviews during the first visit. To account for the approximate distribution of effort for these individuals, I asked the project director to draw parallels and cite similarities between them and faculty who had been interviewed. This information was then used to estimate their activity profiles. A brief questionnaire was used to supplement the second site visit in order to reach all faculty who had been involved in the project.

Salaries and the fringe benefit rates were obtained through the Executive Vice President's Office after the site visit. Salaries were assumed to represent an academic year of 180 days. Summer pay was assumed to represent six-week periods (30 days). Fringe benefits are included in all salary computations. Investment costs and some operations costs were taken from draft Account Status Reports dated 5/30/79 and 4/1/80.

Constructing costs from faculty and staff interviews provides more accurate information about costs incurred than other available methods. (Neither time clocks nor daily journals were used on this project.) Frequently, personnel spend more or less time on a project than they or anyone else planned and they are the best judge and recorder of what they did and when.

Results

The project budget as originally proposed is shown in Table 6. Table 7 summarizes total project personnel costs. Instructional development costs include both faculty and computer center personnel staff who assisted faculty. Table 8 reports the administrative costs in more detail and also reports non-personnel costs. Table 9 details the cost of the most significant portions of inservice training and instructional development cost: those related to faculty involvement. The purpose of the table is to permit judgments about the relative magnitude of release time

Table 6

Central City Junior College's CAUSE Project
Original Proposed Budget

Line Item	NSF	CCJC	Total
Salaries, Wages and Benefits			
11. Director.	$ 51,250	$ 22,250	$ 73,500
12. Professional Staff.	30,600	30,600	61,200
13. Assistants.		12,960	12,960
14. Project Coordinating Council.		8,100	8,100
15. Secretarial and Clerical.	12,300	12,300	24,600
16. TOTAL: Salaries and Wages.	94,150	86,210	180,360
17. Staff Benefits (when charged as direct costs)	22,596	20,690	43,286
18. TOTAL: Salaries, Wages and Benefits (16 & 17).	116,746	106,900	223,646
Other Direct Costs			
19. Guest Lecturers	3,125		3,125
20. Staff Travel.	600	1,500	2,100
21. Field Trips		2,000	2,000
22. Laboratory Materials.	16,340	3,260	19,600
23. Office Supplies	5,400		5,400
24. Non-Expendable Equipment.	56,600	28,300	84,900
25. Office Equipment.		2,140	2,140
26. Advisory Committee.		600	600
27. Renovation.		5,000	5,000
Evaluation (Project Analyst).	12,000		12,000
28. TOTAL DIRECT COST.	$ 94,065	$ 42,800	$136,865
30. TOTAL COST OF PROJECT.	$210,811	$149,700	$360,511

Table 7

Personnel Costs

Activity Functions	Year One	Year Two	Year Three	Total	Cost Distribution (approximate)
Inservice Training[a]	$ 36,530	$ 23,330	$ 20,060	$ 79,920	18%
Instructional Development[b]:					
-Faculty	75,640	51,950	73,910	201,500	44%
-Administrative Service	5,220	3,990	2,780	11,990	3%
Dissemination	4,270	3,360	7,950	15,580	4%
Administration	42,180	48,040	52,820	143,040	31%
	$163,840	$130,670	$157,520	$452,030	100%

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[a] Inservice Training includes faculty time, guest lecture, release time payments and evaluation.

[b] Administrative staff time for instructional development indicates time spent by computer center staff instructing faculty in use of facilities and assisting in design and production of faculty projects.

payments compared to faculty activity.

The inservice training costs in Table 9 do not coincide perfectly with Table 7 figures because both inservice training and instructional development costs in Table 7 include release time payments. In addition, inservice training included (1) guest lecture costs, (2) some of the project director's costs, (3) a portion of evaluation costs, and (4) uncompensated (by release time payments) faculty time. Of these costs, only release time and uncompensated faculty time are reported here. The uncompensated time first appears in year two when faculty were given one hour release time for the three-hour course.

Table 10 summarizes the personnel costs included in Table 7 and identifies the amount budgeted for these personnel. The difference is labeled excess contribution.

Table 11 reports costs identified during the interview process as instructional effort which used materials developed during the project. These costs are not supported by NSF and are provided only as an indication that project-developed materials are being used.

Discussion

The second note on Table 8 identifies a discrepancy between the estimated costs for "council/advisory group" and the costs reported in the college internal statements of accounts. This discrepancy is due to the differences in cost approach used in this report and that employed to compute the college accounts. The college accounts are set up to assign portions of specific costs to specific accounts. Costs identified in this report were established by interviewing the persons whose costs are allocated. The noted difference indicates that council members did not

Table 8

Administrative and Investment Costs

Cost Center	Year One	Year Two	Year Three	Total
Administrative Personnel, Computer Center Staff[a],	$ 42,290	$ 45,960	$ 52,900	$141,150
and Council/Advisory Group[b]	$ 3,590	$ 4,410	$ 1,440	$ 9,440
Supplies[c]	$ 1,520	$ 1,660	$ 1,710	$ 4,890
Office Equipment	$ 2,410	--	$ 170	$ 2,580
Renovation[c]	$ 1,010	$ 240	$ 950	$ 2,200
Equipment/Hardware[c]	$105,510	$ 5,010	$ 6,130	$116,650
Materials/Software[c]	$ 18,870	--	$ 830	$ 19,700
	$175,200	$ 57,280	$ 64,130	$296,610

[a] Computer center staff includes director, secretary and student assistant.

[b] Council/advisory group includes advisory group expenses as reported in 5/30/79 Account Status Report plus council costs as reported by council members and other faculty who stated they were involved in policy meetings/discussions. Discrepancy between these figures and 5/30/79 Account Status Report (approximately $2960) is discussed in text.

[c] Figures are taken from 5/30/79 and 4/1/80 Account Status Reports.

Table 9

Faculty Related Costs by Content Area

Content Area and Activities	Year One	Year Two	Year Three	Total	% By Content Area	% of Total Project Costs
Social Sciences						
Inservice Training	--	$ 2,120	$ 6,730	$ 8,850	8%	
Instructional Development	$ 30,300	16,490	41,680	88,470	75%	
Released Time	11,250	4,960	4,040	20,250	17%	
TOTAL	$ 41,550	$ 23,570	$52,450	$117,570	100%	43%
Life Sciences						
Inservice Training	--	$ 5,580	$ 650	$ 6,230	10%	
Instructional Development	$ 17,540	17,670	3,900	39,110	63%	
Released Time	10,530	4,230	2,440	17,200	27%	
TOTAL	$ 28,070	$ 27,480	$ 6,990	$ 62,540	100%	23%
Physical Sciences						
Inservice Training	--	$ 4,620	$ 4,280	$ 8,900	10%	
Instructional Development	$ 27,800	11,720	17,830	57,350	63%	
Released Time	10,530	4,580	9,400	24,510	27%	
TOTAL	$ 38,330	$ 20,920	$31,510	$ 90,760	100%	34%
GRAND TOTAL	$107,950	$ 71,970	$90,950	$270,870		100%

Note: Evaluation and Guest Lecture costs do not appear above. These costs are included in Table 6.

identify enough time in council activities (which the analyst defines as activities unique to policy determination and evaluation) to account for $2,960.

This discrepancy is not significant because the council members spent considerably more time in other project related activities than was budgeted. These activities included providing assistance to other faculty working on the project, providing demonstrations to faculty groups, and designing computer-based instruction -- appropriate roles for council members. The $2,960 simply appears (and is in fact exceeded) in other activity areas.

The point to be made by this discussion of the $2,960 discrepancy is to emphasize that a one-to-one relationship of the estimated personnel costs with college reports of accounts should not be expected. The direction of differences means nothing unless viewed in the context of the entire cost-picture.

The cost data indicate that the college contributed a great deal of resources to the project. The excess cost of CCJC contribution reported in Table 10 can be viewed as an indicator of college and faculty support for the CAUSE program. Uninterested faculty would not have involved themselves in the project to the extent of the excess contributions. The ratio of contributed cost to budgeted contribution may also be viewed as an index of support. An index of 1.00 would indicate compliance, but not necessarily support. The index at CCJC is 1.59.

The bulk of the excess contribution appears to be due to faculty instructional development activities which account for approximately 65-75% of the faculty related costs depending on the division. The amount

Table 10

Personnel Costs Compared With Budget

TOTAL COSTS (from Table 2)	$452,030
Amount Budgeted for Resources	-164,810
	287,220
Less the Budgeted CCJC Contribution	-111,000
"Excess" CCJC Contribution	$176,220

Table 11

Costs Resulting From Implementation of Computer-Based Materials, 1977-1980

Content Area	1977-79	1979-80	Total	% of Total
Social Sciences	$4,050	$19,310	$23,360	63%
Life Sciences	700	2,010	2,710	8%
Physical Sciences	3,230	7,530	10,760	29%
TOTAL	$7,980	$28,850	$36,830	100%

Note: Costs represent faculty time only.

of instructional development activity generally increased each year as more faculty were introduced to the concept and previously introduced faculty became more involved. In addition, approximately 50% of the second year's release time and 65% of the third year's was provided in order that faculty could pursue their interest in developing computer programs.

Of the divisions involved, the social science division appears to have accounted for the greatest relative amount of involvement (42%, see Tables 9 and 11). This finding appears to contradict a previously reported indication that the social science faculty were less involved. In terms of numbers of individuals that statement is fair; however, several of the social science faculty were very interested indeed and spent much time developing computer programs.

The institution's interest and support for the project appears manifested by the amount of release time provided for the project and their willingness to support the computer center when NSF funding terminates. Even accounting for the fact that the project director was on CCJC staff prior to the project and that the new administrative structure for the center calls for sharing the facility with the academic division of Business Accounting, this seems a significant step. The administrative personnel costs, which were about $50,000 a year must continue to be supported and current budgeting plans indicate they will be supported at a higher level.

Faculty support for the project appears manifest in the fact that they have produced and have implemented instructional materials for their courses (see Table 11). In short, cost and effort data collected by this analyst suggest that the project has had a positive impact on the institution.

Addendum

Mechanics of release time. "Release time" has been frequently invoked at CCJC in connection with the CAUSE grant. The following information may serve to describe how the process works:

1. A full faculty load is 15 or 16 credit hours (e.g., five 3-hour classes or four 4-hour courses).
2. Faculty carrying overload are reimbursed at $414/hour under the label "release time". Much of the instructional development activity was carried out under these conditions.
3. The term also applies to faculty who are released to assume other duties. Their replacements (if any) are paid according to the amount of release time. It is in this sense that release time contributes to inservice training costs.

AN AUDIO-VISUAL TUTORIAL COURSE
IN INTRODUCTORY CHEMISTRY
COLLEGE OF THE MOUNTAINS

Site Visitors: Thomas Allen
Terry Coleman
Richard Lent

Primary Author: Terry Coleman

Preface

College of the Mountains serves a large student population with a diversity of two year instructional programs. The CAUSE project at the institution was very specifically focused on a single course offering in the chemistry department and primarily involved the revision of audio visual instructional modules for a two-semester Introduction to Chemistry course.

In this project, the success of activities bears a clear relationship to the degree of pre-proposal experience and planning. While the project overall was effectively implemented, those aspects of the project which did not have a clear connection with primary project objectives proved to have limited success.

In order to protect the privacy of the participants of this case study the names of people, places and the college have been changed. Fictional names have been substituted; no real names have been used.

Introduction

College of the Mountains is a two-year postsecondary institution in the southwestern part of the United States and serves a medium-sized city and its environs. Overall student enrollment has held relatively steady over the past several years at approximately 21,000, 13,000 of which are part-time. The student population in technical and occupational programs, however, has been increasing while that in the academic areas has been decreasing. About 75% of the students are enrolled in 20 liberal arts programs with the remainder in the 26 vocational/occupational program areas offered by the college. Faculty number 495 full-time and 545 part-time members. The institution supports an open door admissions policy and maintains both developmental and accelerated programs for students.

The college is supported jointly by local community and state funds. The federal government is the largest employer in the area with five or six major military bases in the immediate vicinity. Since federal properties are tax-exempt, the tax base of the community is relatively small. Thus, more of the college's funds come from the state than from the local community.

In 1976, the Chemistry Department at College of the Mountains was awarded a three year, $186,275 CAUSE project grant, with an institutional commitment of $14,902. The CAUSE grant has enabled the department to revise and expand an audio-visual tutorial (AVT) format for its two semester introductory chemistry course (Chemistry 401/402). In addition to an extensive software revision/development effort, the project called for renovation and expansion of the AVT center and an adjoining laboratory area, and for the acquisition of various pieces of scientific lab equipment.

The Site Visits

Three of us visited the project a total of three times. Two of us made two separate visits as a site visitation team. The third site visitor, a cost analyst, made one visit. The first visit of the site visit team and the cost analyst visit took place toward the end of the final year of CAUSE funding. The two-person site visit team made its second visit after termination of CAUSE funding. The schedule of these visits was as follows:

March, 1979	Thomas Allen and Terry Coleman
July, 1979	Richard Lent
October, 1979	Thomas Allen and Terry Coleman

Since all visits to the sites occurred either during the final months of project funding or after funding had ceased, we were not able to observe project functioning during critical developmental stages. We were, however, in the position of viewing the project and its outcomes after three years of CAUSE funding. Our major goals during the visits were to understand the project (in its present form) and to determine the key processes and factors operating during its developmental years. The primary information collection techniques we used were: interviews with faculty and staff, both those who had participated in project activities and those who had not; interviews with administrators and students; observation of the operation of the AVT center; attendance at non-AVT classes; and review of both instructional materials developed and other relevant project documentation.

Project Implementation

Background of the CAUSE Project

Challenges facing science departments at College of the Mountain are similar in many ways to those faced at junior colleges (and four year institutions) nationwide. A declining student population in academic areas and an open door admissions policy resulting in a student population with a wide range of abilities and interests are forcing administrations and faculty to re-examine traditional notions of the missions of their institutions and to reconsider strategies for delivering a multiplicity of high quality instructional programs to a student population diverse in needs and abilities. At College of the Mountains, two large bilingual student populations (Spanish-English and Iranian-English) compound these problems.

In 1971 a small group of faculty in the Chemistry Department at College of the Mountains began experimenting with an alternative mode of course delivery. Their approach was to design a series of audiotape and slide programs which would replace the lectures. The rationale for the approach was to provide a course option which would be more flexible in meeting individual student learning styles. Over several years, these faculty developed slide-tape programs to cover most of the content for the two semester "bread and butter" course of the department--Introduction to Chemistry (401/402). Monies received under a Title VI grant enabled the department to convert a classroom into an AVT (Audiovisual Tutorial) center by installing carrel stations outfitted with rear screen slide projectors and audio cassette players. Students were offered the option of enrolling in AVT or lecture sections of the course. Students selecting the AVT option completed the course by working through the slide/tape programs and the accompanying student guides.

By 1975 it became apparent that if the AVT course was to continue successfully, major revisions were needed in the materials. Several of the faculty in the department were discontented with the course because of what they perceived to be the low quality of the slide-tape materials. As one faculty member put it, "They just weren't what they were advertised to be." This faculty member had been advising students not to take the AVT course option because of what she perceived as its poor quality. She did, however, state that she saw the value of the AVT concept, particularly for students of lower ability and for students who had language difficulties. She and other faculty members described the problem with the original slide tape modules as including insufficient level of detail, content inaccurtes, and poor technical quality of the audiotape and slide materials themselves. One faculty member mentioned that the course modules were written at the "whim" of one or two persons and that the content and types of presentation were too idiosyncratic to the individual styles of those faculty writing the materials. Institutional monies, however, were not available to undertake the large revision and development task which was called for.

Responding to an NSF brochure sent to the science departments at the college, Dr. Carter Shulman, Chairperson of the Chemistry Department and Dr. James Harmon, Chairperson of the Biology Department, attended a regional CAUSE informational meeting. Both the Biology and Chemistry Departments subsequently submitted separate proposals to the college administration to seek support for submission of a CAUSE proposal. The biology proposal called for the establishment of an AVT course somewhat like chemistry's. In order to implement biology's project, however, additional space would be needed since the Biology Department was (and is) very cramped for space. Since it was their understanding that CAUSE monies were not funding new building construction or building additions, only facilities renovation, and since the Chemistry Department was able to demonstrate more concrete prior effort (a stated criterion in the awarding of a CAUSE grant), the college administration decided to support chemistry's proposal.

The specific objectives of the project, as expressed in the proposal to CAUSE, were to revise the existing AVT software materials in order to improve their quality and effectiveness, to better coordinate classroom (content presentation) and lab work, and to better diagnose student entry levels for the purpose of prescribing appropriate learning experiences.

The AVT Course Today

The Chemistry Department at College of the Mountains has four courses at the introductory level. Chemistry 300 is a developmental studies course designed to prepare students for college level courses; Chemistry 305-306 is a course designed for non-science majors; Chemistry 406 is a one semester course for students enrolled in the nursing curriculum. Chemistry 401-402 is required for students enrolled in chemistry, physics, engineering, mathematics, and pre-professional medicine or dentistry curricula.

Chemistry 401-402, a eight-credit sequence of courses, is the largest departmental offering, and enrolls an average of 500 students per semester. It is the only course in the department which is offered in the AVT format. Students enrolling in the course are given the option of either an AVT or lecture section with the freedom to switch sections at the end of the first semester. Though no precise data were available, the project director reported that a small percentage of the students (approximately 5-10%) do choose to change sections at the end of the semester with approximately an equal number switching to one or the other format option. During any given semester, the student population in Chemistry 401-402 is approximately one third AVT and two thirds lecture sections with five or six AVT sections being offered concurrently with 10 or 11 lecture class sections.

The AVT course is self-paced in that students have the opportunity to progress through a set of modules at their own rate. However, various constraints are placed on students to ensure that they do not fall too far behind during the semester. Quizzes on course content and/or out-of-class components are given on a regular basis and are graded for periodic assessment of student performance. Examinations are given once a month. Lab assignments must be submitted the day following the scheduled lab session. The project director told us that over the several years during which the AVT course has been functioning they had experimented with various procedural rules. Experience indicated that relatively stringent constraints on the degree of self-pacing allowable to a student over the span of a semester were necessary because many students, he explained, did not possess sufficient self-discipline to structure their own work.

Class sections of the AVT course meet at regularly scheduled times in the AVT center. Students are also given the opportunity to use the slide/tape programs on their own time, assuming the availability of a carrel in the center. Typically, on Mondays, Wednesdays, and Fridays the center is booked solid with classes and lab sessions. On Tuesdays and Thursdays, the scheduling load is lighter with more carrels available for independent student use. A student obtains an appropriate module from the check-in/check-out desk located between the carrel and laboratory areas of the center. A full-time non-teaching professional assists students in this process. Twenty to thirty copies of each module are available. The student then returns to one of 35 carrels located in the AVT center. We randomly selected one of these carrels and found that it was equipped with a Wallensak 3M-Cassette Guardian playback unit, a Sawyer's Cartridge slide tray projector, a rear screen viewer, a Texas Instrument Model 30 calculator, and a remote slide projector control unit.

We selected one audiotape/slide module ("Predicting Products of Chemical Reactions") for review. Though no written instructions relating to hardware/software use were included, Mrs. Martin, the full time non-teaching professional who works in the center, provided oral instructions demonstrating how the hardware was operated. It was obvious that the demonstration was a practiced routine and that it had been given many times in the past. Synchronization of the visuals with the commentary was accomplished manually by advancing the slides when an audible tone was heard on the cassette tape.

The module content covered four types of chemical reactions. There were periodic instructions to the students to stop the program and to complete the activities located in the accompanying study guide. At the completion of the lesson, students were to complete a set of assigned questions in the study guide. This particular module contained 31 slides and approximately 20 minutes of commentary. One or two examples of each type of chemical reaction were presented and explained. Four questions, involving quantitative problems to be solved, were included in the concluding activity. Answers to these questions were found at the end of the study guide.

We interviewed two students who were working through audiotape/slide programs on their own in the AVT center. Both reported that they had enrolled in an AVT section of the course primarily because the class meetings fit their schedules. Both students, however, stated that they preferred it to lecture classes.

For one of the students, it was the first time he had taken an AVT-style course. He thought that he would not get as much information out of a lecture because he would not have the opportunity to go back to sections he did not understand the way he could with the AVT modules. He admitted that some students may find the AVT course boring, but he believed that everyone learns best in a different way and that the AVT way was a good way for him.

The other student reported that he liked the AVT option not only because it allowed him more flexibility in scheduling his time (he was employed full time and often came in to work at the AVT center outside regularly scheduled classes) but also because it allowed him to work at his own pace and to go back to sections which he did not understand the first time. He also cited the advantage of having a low-key atmosphere to the class which he found to be less threatening if he needed to ask the instructor a question. He thought that AVT classes were good for introductory, basic courses such as Chemistry 401/402, but that more advanced classes required more active group participation.

A study had been conducted by one of the chemistry instructors to determine whether student learning in the AVT course increased subsequent to the revision process. An examination based on local and national examinations was "hybridized" and administered to two groups of students. Group One consisted of students who had completed one semester of the AVT course prior to the revision process. Group Two consisted of students who took the course after revisions in the modules had been made. Comparison of group examination scores indicated higher academic performance by the second group. Several factors, however, preclude definitive conclusions being drawn from the findings of this study. The absence of validated instrumentation calls into question the validity and reliability of the student outcome data. No estimate of the relative equivalence of the two groups in terms of entering ability is available. An influx of a substantial number of foreign students into the course during the second testing phase introduced, in addition, an unexpected confounding variable. No data relating to the relative effectiveness of the AVT and lecture formats have been collected.

To establish a basis of comparison between the course content of the AVT and lecture sections, one of the site visitors attended a lecture class covering content similar to that presented in the previously described AVT module. The lecture was traditional in format and presentation style. Several types of chemical reactions were covered and examples of each were provided. Though some difference existed between the AVT module and the lecture in terms of the examples and explanations given, these differences were relatively minimal. When queried, the instructor explained that she didn't use the study guide or any of the AVT modules with the lecture class because the lecture class was organized according to the established textbook for the course which is not used with the AVT section. In her opinion, however, the content for both the AVT and lecture sections was essentially the same.

Two students were interviewed immediately after the lecture. One of the students reported that she knew nothing at all about the AVT center or the class sections which utilize it. The other student knew about the AVT option, but preferred the traditional lecture format. He added that he had once taken a biology course at another institution that was entirely audio-tutorial in format. He did not enjoy the experience and stated, "I didn't like it...when I ask a question I want an answer from a teacher--this isn't possible with machines."

Overview of Project Activities

Project activities primarily consisted of the renovation and expansion of the existing AVT center and the revision of the AVT course modules which had been in existence prior to the CAUSE grant.

In order to accomodate a larger number of students in the course and to provide a physical arrangement conducive to more effective integration of classroom and lab work, a wall was removed from a classroom adjacent to the original AVT center and a chemistry laboratory was constructed to accommodate thirty-five students during the first project year. The number of carrels in the center was increased and a seminar/conference room was established in a room adjoining the expanded AVT center.

In addition to the lab equipment and carrel furnishings acquired, two CRT terminals (connected to the college's IBM 370 computer) and videotape playback equipment were purchased. Recently, with CAUSE monies not expended during the three year duration of the project, four APPLE microcomputers were purchased. These can be found in the AVT center.

During the first year of project implementation, eight of the twelve full-time chemistry instructors were given one third release time to work on materials revision; during each of the two subsequent years of the project, four faculty were given this release time. Part-time instructors were hired to assume the teaching responsibilities from which the faculty working on the project were released. All course modules were revised and several additional modules were developed.

The module revision process consisted of a clearly articulated set of discrete steps. First, a committee (consisting of all faculty working on revisions) met and assigned individuals responsibility for specific modules. Generally, faculty worked on modules which they felt were most in their area of expertise and in which they had the greatest interest. Each instructor individually made necessary revisions in the material and passed out the revised module to committee members for review. At first, all committee members reviewed all modules but this soon proved to be overly cumbersome and inefficient. The strategy was changed, therefore, to include a four member subcommittee review of revised modules.

Several faculty reported to us that disagreements between the primary author/reviser and the reviewing group sometimes arose about the adequacy of particular aspects of a module. In these cases, the primary author/reviser was invested with authority for a final decision. It was reported, however, that in most instances, the changes suggested by the reviewing group were incorporated into the materials. Once the module was revised again by the primary author/reviewer it was again passed back to committee members for final review and approval. Each module took approximately six weeks to cycle through this process.

Revised modules were then sent to the college's AV center staff for final production. Most of the tapes utilized individual author's voices since it was found that although there were excellent voices available through the AV center, their lack of specialized knowledge in chemistry sometimes resulted in mispronunciation of terms and inaccurate phrasing. Approximately 75% of the original set of slides were redone to both improve the conceptual clarity of the content they presented and to improve their technical quality.

The revision of all slide-tape programs for both semesters of the course was completed by the fall 1977 semester. The number of original modules totalled 120. After the division process, the total number was reduced to 96 since several modules were"collapsed" into single units.

By the end of the spring 1978 semester, 31 newly developed laboratory-related modules for both semesters were completed. These audiovisual lab materials have supplanted the commercially purchased lab workbooks which were formerly used.

Faculty who worked on the project told us that the revision process was a highly labor intensive activity which often required several full rewrites of module material. One faculty member reported that he was very conscious of the fact that his work was going to be carefully reviewed by his peers and that sometimes the criticisms from committee members were ego damaging and difficult to take. Another faculty member commented that sometimes a primary author/reviewer had to compromise with different approaches to the presentation of content in a module.

The revision process utilized appears to have been an effective strategy for at least two reasons. First, it emphasized multiple review and feedback cycles. Thus, individual modules were subjected to scrutiny by more than one individual author. Undoubtedly this served as a quality control mechanism and helped ensure a level of consistency across modules. Second, the process involved the active participation of many of the instructors who would ultimately be implementing the AVT course. Comments by several faculty members indicated that this increased faculty perception of "ownership" of the materials and served to lessen faculty resistance to their use. The project director further believes that local development of the materials has meant that they fit the philosophies and instructional approaches of the faculty who use them better than commercially produced materials could.

One of the original goals of the project had been to develop a computer-based system which would be capable of serving as a diagnostic and prescriptive tool in individualizing learning experiences for students. For this purpose two CRT terminals were purchased and connected with the college's IBM 370 computer. From conversations with the project director and several faculty members it became evident to us that the complexities and ramifications of developing such a system had not been carefully and thoroughly planned prior to submission of the CAUSE proposal. In addition, as the project director reported to us, use of the computer was not in actuality perceived as a central focus of the project. Consequently, this goal was not realized.

During the three years of project implementation, however, an item bank which had been developed prior to CAUSE funding and stored in the college's computer, was completely revised as part of the overall revision process and was expanded. The items (multiple choice questions) are organized by topic area and can be accessed by instructors on a random basis to generate course quizzes and tests. Several faculty, particularly those teaching the AVT course reported using the bank, but no data are available to determine the extent of this use.

Attempts to use computer capabilities for other instructional applications have been made and are continuing. A software program, developed at a nearby state university and designed as an interactive drill exercise for students in various topic areas in chemistry, was obtained by the Chemistry Department and intended for use as a supplemental instructional aid. Utilization of the program, however, proved difficult due to problems encountered in interfacing the program with the college's computer operating systems. Local generation of interactive instructional programs on the 370 system proved disappointing too due to additional problems encountered in the use of super-and sub-scripts required for the writing of chemical equations and due to the complexities of writing such programs in FORTRAN, a language known by only a few members of the chemistry department.

The recent acquisition of APPLE microcomputers is likely to increase the probability that interactive programs supplemental to instruction will be available for use shortly. Faculty in the department appear enthusiastic about the potential of the microcomputers and since it can be programmed in BASIC its use is probably more feasible for a larger number instructors. Several faculty reported to us that they were working on programs which they hoped to use as an aid in instruction. Given that only four APPLE units are available, however, it is unlikely that computer instructional programs can be supported on a large scale.

The Faculty View

Since the inception of the AVT course, all but one of the 12 chemistry faculty members have taught it at one time or another. It appears, however, that approximately five to six teach it on a regular basis. Most of those faculty who teach the AVT course during a given semester also teach at least one lecture section.

Carter Shulman, chairperson of the Chemistry Department, has been director of the CAUSE project since its inception. Carter believes that among the accomplishments of the project, the one which has caused the most significant change is the integration of the lab and content presentation components of the course. Prior to the CAUSE project, students typically had one instructor for the content presentation component of the course (lecture or AVT) and another for the lab experience. The addition of a lab area contiguous with the AVT carrel work area has enabled flexible scheduling of instructors such that AVT students now have the same instructor for both components of the course. The local development of a series of AVT lab modules (coordinated with the sequence of the other AVT content presentation modules) helps ensure the integration of students' learning experiences in the course. Carter reported that the lab modules have been so successful that they are also being used as the departmental standard for the lecture sections of the course.

Carter believes that without CAUSE funds the revisions, begun prior to the CAUSE proposal, would have continued but at a much slower pace. The college might have been able to provide some funding for release time, but he does not think it could have been very much. He estimated that the modules in their present state would probably be sufficient for about five years after which advances in the field would probably require the updating of technical content.

At present, the Chemistry Department has no plans to expand the AVT approach to other courses in the department. Carter stated to us that the development of such courses is feasible and cost-effective only for large enrollment courses such as Chemistry 401/402. Chemistry is the only science department on campus which utilizes an approach such as AVT and Carter does not think that any of the other science departments have plans to implement one in the near future. He mentioned that the Biology Department probably would like to develop an AVT program or two for their large enrollment introductory courses but that space limitations were preventing them from doing so.

Carter's self-reported role as project director was primarily as a coordinator and a communicator of information. Major decisions, he reported, were made on a consensus basis, with all faculty working on the project participating. He did not remember any situations where major disagreements among faculty developed which required his intervention as an overt "tie-breaker". He reported that generally, the relationships among faculty in the department were comfortable and that there existed an "harmonious" working relationship.

Kent Gallagher became involved in the AVT project in the spring of 1971. Without the release time afforded by the CAUSE grant, Kent does not believe that he would have become active in the revision process. He believes that the strongest asset of the AVT course is in its remediation capabilities. Students have the option of viewing a program as many times as they wish and can proceed at their own pace. Immediate intervention by the instructor is possible. Kent feels, however, that an inherent weakness of the program is the fixed media approach. If a student does not understand the concept presented in the lesson, review of the lesson a second time is only a repetition of the same explanation. The versatility of giving a different explanation or example is not possible with a slide/cassette format. Asked how this problem could be alleviated, Kent suggested that multiple explanations could be recorded without manufacturing any new visuals. This would make available to a student experiencing difficulty a different explanation and a fresh approach to the lesson. Unless a student is highly motivated and possesses self-discipline, he believes, it is unlikely that the student will successfully master the course content without instructor intervention.

Martin Loomis was among those instructors who had begun development of AVT modules in 1971. He explained that development of the AVT course was an attempt to account for the varying learning styles of different students. According to Martin, the original set of modules had been sketchy in content, poor in the quality of visuals, and too heavily reliant on the textbook which was the department's standard at the time.

Martin was the only instructor interviewed who was using the AVT study guide in conjunction with the textbook in his lecture class sections. He reported that the course content and hourly and final exams are identical for all students whether enrolled in AVT or lecture sections. He believes that unless students who take the AVT course are self-disciplined and possess good study habits they will fall below their lecture counterparts in learning. When asked what he as an instructor had gained from working on the project, Martin responded that the opportunity to work closely with other members of the department and to learn different instructional techniques had been extremely beneficial experiences.

Shelly Shulman worked on the revision of materials during the first CAUSE funding year and teaches both AVT and lecture sections of Chemistry 401/402. She wishes that there were some reliable way to determine at the start which students would most benefit from the AVT approach and which would most benefit from the lecture approach. Some of the students just do not belong in the AVT course, in her opinion, either because they do not possess enough self-discipline or because they do not have good study habits. According to Shelly, such students typically go through the materials very quickly, do not fill out the study guide, and usually leave early. She estimated that out of a hypothetical AVT class of 30 students, usually about six could benefit more from the lecture class.

Shelly is concerned that many times students in the AVT course do not ask enough questions about the material. She believes it is necessary to "inspire" motivation in the students if possible. To this end, she usually incorporates a brief presentation/discussion session in each of her regularly scheduled AVT classes.

Walter Collins did not participate in either the original writing of modules or in the revision process, but he has taught several AVT sections. At first his attitude toward the AVT course was negative, he reported, since he thought that the method was too impersonal. He also did not like the idea that students could re-take exams without penalty, a practice which has recently been eliminated. From experience, however, he found that students actually ask more questions in the AVT course and have more personal involvement with the instructor than in the lecture section. He also sees AVT's advantage for slower students and for students who have language difficulties; he reported that some students just cannot grasp certain concepts from a lecture. Several students from his lecture classes, he stated, use the AVT program for review purposes.

Dr. Martha Hermann was not at all happy with the AVT materials as they existed in 1975, and so she became actively involved in the revision process during the first project year. She now believes that the AVT and lecture courses are equal in quality for the bulk of students who take Chemistry 401-402. The self-pacing, she explained, is particularly useful for slow learners and for learners with language difficulties; some of the more accelerated students she thinks, however, find the AVT course a bit boring. She stated that the work involved in revising the modules was more than anyone had expected and that it was sometimes difficult to deal with the interpersonal factors involved when a group of peers get together to criticize each others' work.

Dr. Wayne Taylor was one of the prime movers in the development of the AVT approach in 1971. Wayne recalled that the concept had developed after three faculty members had taken a course on individualized instruction at a nearby university. He reported that four faculty members were involved in the initial writing of the modules and that there had been a good deal of resistance to the concept among other faculty at first. This resistance has been greatly mitigated, according to Wayne, because of the improvements in the modules and because of the wider involvement of faculty in their development and revision.

Wayne is not quite sure what factors make the AVT course more successful for some students than for others. This question was the subject of his dissertation, but Wayne admitted that he did not uncover much useful information. He does believe from experience, however, that the AVT approach is particularly suitable for students of lower ability, as long as they have the self-discipline and motivation to use the available materials effectively.

To learn the extent of diffusion of the project innovations to other science departments on campus, we spoke with the chairpersons of two other science departments. One, Jim Haskell, chairs the largest science department on campus, Biology. The other, Dr. Martin Renter, is chairperson of Earth Science, the smallest of the science department.

Mr. Haskell estimated that between 2400 and 2600 students pass through courses in his department each semester. Faculty in the Biology Department number 21 full time and approximately 18-20 part-time instructors. He stated that he was disappointed when chemistry had been chosen over biology by the college administration for submission of a CAUSE proposal, but realized that chemistry's chances were much better because of their prior involvement in the project and because of biology's space problems. When asked if there had been any discussion of submitting a joint chemistry-biology proposal, he said that that was never much of a consideration since each department operated separately, worked independently, and didn't have much experience in combined approaches to things. He cited a certain lack of "cohesiveness" among the science departments. He thought that perhaps if chemistry and biology shared the same building a joint proposal might have been more of a possibility. He hadn't considered a joint proposal with the Physics Department (with whom biology does share a building) since he did not think they would have a very positive attitude toward AVT and also because he thought there would be "territory" problems.

Although technically his department could now apply for a CAUSE grant since the chemistry project has terminated, he does not think that is a good possibility primarily because of the square footage problems. Funds are readily available for other department needs, such as buying equipment, but money is not available to help alleviate the physical space problems. Apparently the laws of the state specify that state funds cannot be used for construction purposes at junior colleges, although state funds can be used for such purposes at state-supported 4-year colleges and universities. The money for building construction must come from the local community, and the community does not have a large enough tax base to support much construction.

Mr. Haskell reported that he did not have any really specific knowledge about chemistry's AVT course. He said that students who come through biology courses which require Chemistry 401/402 as a prerequisite seem very well prepared, but he had no knowledge of which students had taken the AVT class sections and which had taken the lecture class sections.

Several of the biology faculty have been pushing for the establishment of an AVT center, but Mr. Haskell does not see that happening in the near future. He believes that the large introductory courses in the department (Anatomy, General Biology and Physiology) would benefit most from an AVT approach. He believes that the advantage of the AVT approach is that students can proceed at their own rate and repeat sections which they do not understand at first; he also believes that the AVT approach would benefit the institution because it would accomodate more students. He does not believe the AVT approach would work very well in the more advanced courses because the content is too complex, the enrollment is much smaller, and there's too much lab work involved. He believes too much patience and personal attention is required on the part of the instructor to warrant AVT in remedial classes.

The Earth Science Department enrolls approximately 300 students each semester. Dr. Martin Renter, its chairperson, admitted that he didn't have too much specific information about the AVT chemistry course. He had reviewed one or two of the modules and had been impressed, but had not seen or heard any particular evidence about how the program was running except for an occasional student comment which he reported to be generally favorable.

Dr. Renter guessed that AVT programs would probably work best for what he described as "middle ground" students who were motivated to succeed in the course. For students who were not motivated to begin with, he thought, an AVT approach might demand that they would take more personal responsibility for their work in the course than was warranted. For very bright students, he feared that what he described as the "1-2-3" approach and the repetition of AVT programs might bore them. He also thinks that the AVT approach might be very good for students who have language difficulties. Many times, he reported, the Hispanic population at the college (a sizeable proportion) were at a particular disadvantage because of language difficulties.

When asked if he would like to have AVT courses in his department, Dr. Renter replied affirmatively but said he thought he'd do it a bit differently than chemistry had. He would like to use the AVT approach specifically for lab work very possible only as a course supplement. He envisioned a program which could be run at the beginning of each lab which would provide an overview of the lab and which would also present the lab techniques to be used during that session. Because of what he termed the "traditionalism" of many of the faculty in his department, he expected there would be a great deal of faculty resistance to the idea. He also expressed the concern that resources at the college were becoming tighter and that he didn't know where he would get the money to develop AVT programs even if the faculty wanted them. He thought that the Chemistry Department had been able to gain acceptance of the AVT approach among its faculty primarily because that faculty is young (described as "one of the youngest on campus"), less traditional, and have more background in education as a field.

Comments from the Site Visitors

That a need existed for the revision of AVT modules seems relatively well established. The materials were reported to be, by both original developers and other faculty in the Chemistry Department, inadequate and lacking in quality with respect to both content validity and technical detail. In this sense the CAUSE project helped meet a Chemistry Department need by providing resources so that faculty time was available for completing the revisions. In addition, CAUSE allowed the department to expand its facilities to accommodate more students in the AVT course and to more closely integrate the lab component of the course with content presentation.

At a broader level, the question might be asked, "Were institutional science needs adequately addressed by the project?" To the extent that one department's needs were addressed, institutional science needs have been addressed. The fact that there had been at least one competing proposal within the institution prior to submission of the CAUSE proposal, however, raises the question of how decisions regarding institutional commitments to CAUSE projects are made. Are these decisions primarily made on the basis of the relative value or merit of individual projects in meeting specific institutional needs of high priority or are they made on the basis of which project has the highest probability of being funded? It is not possible to determine in hindsight how the decision was made at College of the Mountains, nor is it appropriate to suggest that all things being equal, the Chemistry Department's project was not of higher merit or priority with respect to institutional science needs. However, it is appropriate to suggest that institutions such as College of the Mountains sometimes face difficult choices between submitting CAUSE proposals which are clearly attuned to institutional needs of high priority and those which possess a higher probability of being funded.

Implementation of project activities appears to have been accomplished in an efficient, effective manner. Project management was reported as participatory in nature. The easygoing working relationships among faculty which appeared evident to us undoubtedly assured that such a participatory style worked relatively smoothly.

The project director, as administrator of the department and of the project, was able to provide immediate credibility and administrative support to project activities. He impressed us as a person who ran a "tight ship", not through authoritative rule but through a comprehensive knowledge of the strengths and weaknesses of individual faculty members and of activities occurring in the department. His decision-making style, by self report, involves consensus-making among those whom the decisions will affect.

Prior experience with the AVT course and with the revision process allowed the project to accelerate to full activity with only minimal start-up time. As previously pointed out, the active involvement of faculty members who could be described as "resisters" to the AVT course helped insure wider acceptance of the innovation across faculty in the department and helped establish a sense of "ownership" of project outcomes.

The problems encountered with the implementation of the computer-related aspects of the project (using the computer as a diagnostic and prescriptive tool) probably stemmed from a number of factors. Primary among these was the lack of front-end planning as to the computer's precise uses in the AVT course prior to submission of the proposal. The computer appears to have been regarded as a "nice to have" adjunct and little thought was given to the implications of what was being proposed. Additional pre-proposal experience might have mitigated what appears to have been overly ambitious plans in this respect.

In addition, several unanticipated logistical problems prevented the project from realizing its goal of incorporating the computer as a prescriptive and diagnostic tool in the AVT course. Among these were problems associated with interfacing externally developed software programs with local-operating system procedures and capabilities, difficulties with equipment design that were not entirely adaptable to chemistry applications, and what was reported to be the somewhat less than enthusiastic cooperation of the college's computing center staff. It should be noted, however, that the project did accomplish a major revision and expansion of a computerized testing item bank and that the acquisition of microcomputer capabilities is likely in the future to enhance, in a supplemental way, the remediation capabilities of the AVT course.

The question of the degree to which the CAUSE project at College of the Mountains has increased the quality of instruction is difficult to answer directly since the evidence of such improvement is essentially non-existent in a formal sense, or is circumstantial where existent. Unanimous opinion among those associated with or peripherally knowlegeable about the project indicates that the quality of the AVT course materials has been substantially upgraded. Expanded facilities which allow the closer integration of content presentation and lab experiences have been provided. AVT course procedures have been refined with the particular intent of guarding against what might be perceived by students to be an "easy way out" and with the intent of insuring that indications of the need for overt instructor intervention into the individual student learning process can be quickly identified.

Faculty and students cite various advantages of the AVT course over the more traditional lecture format. Chief among these are the opportunity for students to self-pace their work and the opportunity for students experiencing comprehension difficulties to go back to specific sections of a module for further clarification. Faculty are careful to point out, however, that the advantages of the AVT course work best for those students whose learning styles match the approach. Unfortunately, attempts at clearly identifying what learning styles work most effectively with which course option (AVT vs. lecture) have not been too successful, a failure which is understandable given the lack of clarity in the broader context of educational research on the interaction of specific types of instructional treatments with specific learner aptitudes.

In our opinion it is unfortunate that the use of AVT materials as a supplemental resource for the lecture course sections has not been disseminated more widely throughout the Chemistry Department. Several faculty reported that they encourage their lecture class students to utilize the AVT materials when lectures were missed or in preparation for examinations. Since specific AVT Center usage data for students not enrolled in AVT course sections were not available, the extent of use of AVT materials as supplements by lecture class students cannot be precisely estimated. However, from discussions with faculty and students, the practice did not appear very widespread. Understandably, logistical problems relating to the number of copies of AVT materials available at any given time and problems associated with space utilization and scheduling hamper such efforts.

As at other sites we visited, the emphasis on evaluation activities appeared to be minimal and yet upon closer examination it became apparent that extensive efforts have been expended in activities which might be described as formative evaluation procedures. The central focus of the project was, in fact, on the specification of the inadequacies of a set of instructional materials and the subsequent use of this information for making improvements in the materials. An elaborate procedure, described in a previous section of this report, which included multiple reviews and multiple feedback loops was used in revising the AVT course materials.

At a broader level, little effort has been expended in evaluation of project functioning or of the functioning of the AVT course itself. One study was conducted by a project staff member which examined the pre- and post-revision achievement of students enrolled in AVT class sections over a two year period. Several confounding variables, previously described, however, mitigate to a large extent the degree to which conclusions can be based on the data which resulted. No formal attempts have been made to examine the relative achievement of AVT and lecture class students, nor have less formal student feedback mechanisms or analysis of student enrollment patterns been utilized.

Summary

In summary, the CAUSE project at College of the Mountains appears to have been a sucessfully implemented set of activities which has resulted in an improved set of instructional materials and processes. Several logistical and planning problems hampered realization of one project goal, (integration of the computer into instructional processes) but subsequent actions (i.e., acquisition of microcomputers) will likely prove to have beneficial results. Unfortunately, the lack of concentrated effort to evaluate project outcomes makes it difficult to assess the degree to which the project has resulted in identifiable improvement in student learning.

Project Costs

This section of the report focuses on this project's use of its resources to achieve its various objectives. The project's original budget and actual costs by functional area of project activity are noted. In particular, the amount of the college's contributed resources is shown to be considerably larger than the amount indicated in the proposal. Consideration is also given to the cost of confirming the CAUSE project's improvements in post-grant years. This section begins with a review of the procedures used by Richard Lent in gathering the cost information.

Procedure

On July 24, 1979, I met with the project director, and two of the faculty most closely involved in the CAUSE project. We met most of the day discussing the project's history, activities, and costs. All three faculty seemed very familiar with all aspects of the project's operations. A number of records, including monthly bills for audiovisual production services, were referred to for specific details. The project director was able to provide salary figures for everyone involved in the project over the three-year period as well as all project expenditures for facilities and equipment. Toward the end of my visit I talked briefly with the director of the computer center regarding that office's services to the project.

At the time of this visit, the project was in the last months of the three-year funding period. Answers to many of my questions thus required a review of events as much as three years or more in the past. However, it was particularly fortunate that the three faculty members had been working closely together throughout the funding period (and for a number of years before) since they had complete knowledge of the project's activities. On several occasions I had an opportunity to ask each of them separately about their own and others' involvement in certain project tasks. Their estimates of time and effort generally seemed to agree and therefore I tend to trust their estimates. In addition, the careful planning that went into this project and the extent of the project members' previous experience with the subject of the project itself appears to have resulted in a remarkably close match between the predicted and the actual level of effort on many tasks.

Areas of Functional Activity.

Project costs can be usefully examined from several perspectives. First, they can be analyzed in terms of the project's major objectives. As described in the proposal the project had three objectives:

> (1) The first objective is the modification of the current audiovisual materials to permit better use by students in lecture classes. At the same time, of course, the changes will be carried out with the idea of improving instruction for those students in the audiovisual sections.
>
> (2) The second objective, to coordinate classroom and laboratory work, can best be achieved if a student performs an experiment immediately after covering the related topic in the Audio-Visual Center. Remodeling of present physical facilities will be required to achieve this goal.
>
> (3) The third objective is to be able to assess the entry level of students and prescribe learning activities to meet their varied needs.

In reviewing these objectives with the project director, it became obvious, however, that the project's activities had not been viewed in quite this way once the project had gotten underway. In fact, he had forgotten that three objectives had been given for the project. Over the years, the third objective's activities (which mainly involved the development of a computer-based testing system) had been considered a special aspect of the first objective's activities. For purposes of the cost analysis, however, all costs associated with the establishment of the computer-based testing system were assigned to the third objective (even though it is not certain that this goal remains as an explicit focus of the project). Finally, a fourth area of project activity, evaluation, was considered to be a separate subject for the cost analysis since discussions with the project director suggested that evaluation involved a distinct set of activities apart from the conduct of the project itself.

Results and Discussion

Table 12 presents total project costs for three years as organized by major items of expenditure and areas of project activity. Direct costs of the project totaled $228,521 of which 44% was devoted to the achievement of the second and third objectives, and 4% devoted to evaluation activities. The largest category of project expenditure was personnel which accounted for 55% of direct costs. Facilities expenditures accounted for 16% of the project's budget. The third largest item of project expense was computer equipment which, when combined with its operation and maintenance expenses represented 10% of direct costs.

The presentation of the project's direct costs in Table 13 differs from the original proposal budget in one very important way: the treatment of personnel expenses. The original proposal (Table 14) requested $75,000 under director and professional staff salaries. However, the project director explained that this figure represented the cost of hiring replacement faculty so that the director and other faculty could be released from part of their teaching responsibilities to have the time to work on the project. Since teaching courses has no direct bear-

Table 12

Total Project Costs For Three Years

By Item of Expenditure and Area of Activity

ITEM	Objective One	Objective Two	Objective Three	Evaluation	Item Total
Project Personnel	$ 77,907	10,249	28,800	8,953	125,909
Student Assistants	5,107		5,472		10,642
Facilities		36,388			36,388
Lab Equipment		11,305			11,305
A-V Equipment		3,768			3,768
Computer Equipment			17,347		17,347
Computer Operation and Maintenance			5,263		5,263
Printing	2,900				2,900
Travel	117	117	116		350
Materials Production	14,649				14,649
TOTAL DIRECT COSTS	$100,743	61,827	56,998	8,953	228,521
			FACULTY REPLACEMENT		77,935
			INDIRECT COSTS		14,902[a]
		TOTAL ALL PROJECT-RELATED COSTS			$321,358

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[a] As given in the original proposal and estimated on the basis of 8% of the total direct costs (originally $186,275).

Table 13

Total Project Costs For Three Years

By Item of Expenditure and Funding Source

ITEM	CAUSE	College	Item Total
Direct Costs			
Project Personnel		$ 125,909	$ 125,909
Student Assistants	$ 10,642		10,642
Facilities	36,388		36,388
Lab Equipment	11,305		11,305
A-V Equipment	3,768		3,768
Computer Equipment	17,347		17,347
Computer Operation and Maintenance	5,263		5,263
Printing	2,900		2,900
Travel	350		350
Materials Production	9,532	5,117	14,649
Total Direct Costs	$ 97,495	$ 131,026	$ 228,521
Other Costs			
Faculty Replacement	75,000	2,935	77,935
Indirect Costs		14,902	14,902
Total All Project-Related Costs	$172,495	$ 148,863	$ 321,358

Note: The estimates of "Total All Project-Related Costs" should not be taken to reflect the cost of the project itself since the faculty replacement expenses were incurred for normal instructional activities that would have been conducted in any event. This particular description of costs is only used to illustrate all resources committed by funding source.

ing on the achievement of the project's objectives, the cost of the faculty replacements is not a cost of the project per se and therefore has not been listed under the project personnel item on Table 12. Instead, the expenses listed under this item on the table (totaling $125,909) represent the salaries of project faculty for the time they actually spent working on the project. The final cost of the temporary faculty hired to replace project faculty in the classroom is listed at the bottom of the table ($77,935).

College's Contribution. As listed in the proposal, the project's direct costs were expected to total $186,275. Considering the project's actual expenses including the salaries paid to project faculty (from Table 13), the project actually cost $228,521. If the cost of replacement faculty was used instead of project faculty salaries following the assumptions of the original proposal, the project's "direct" costs would total $180,547. However, if indirect costs of $14,902 are considered (following the assumptions of the original proposal) along with the cost of replacing faculty in the classroom, and these expenditures are added to the project's actual direct costs of $228,521, the total of all project-related costs rises to $321,358.

The impact of these various interpretations of project costs on the size of the college's contribution to the project can be seen from comparing Tables 13 and 14. Since the college chose not to list the salaries of project faculty in addition to or separate from replacement faculty costs, the college's contribution was listed as $14,902 (Table 14) for estimated indirect costs (which represented 8% of total direct costs). Table 13, however, shows that the college's actual contribution was considerably larger: $131,026 of direct costs or $148,863 of all project-

Table 14

Proposal Budget Summary

LINE ITEM	Requested from NSF	Contribution of host institution	Total
SALARIES AND WAGES			
11. Director	$ 16,000		$ 16,000
12. Professional Staff	59,000		59,000
13. Assistants	4,250		4,250
15. Secretarial and Clerical	2,000		2,000
18. TOTAL: SALARIES AND WAGES	$ 81,250		$ 81,250
OTHER DIRECT COSTS			
20. Staff Travel	$ 1,125		$ 1,125
22. Laboratory and Instructional Materials	78,600		78,600
23. Office Supplies, Communications	2,900		2,900
24. Fees	14,400		14,400
25. Wiring, installation, remodeling	8,000		8,000
28. TOTAL DIRECT OPERATING COSTS	$ 186,275		$ 186,275
29. INDIRECT COSTS		$ 14,902	$ 14,902
30. TOTAL OPERATING COSTS	$ 186,275	$ 14,902	$ 201,177

related costs. Considering direct costs alone, the college actually covered 57% of the project's expenses. If all project-related expenses are considered, the relative size of the college's contribution is reduced to 46%.

Continuation Costs. Table 15 arrays project costs by activity and stage of the project's life (design, investment or operation). Given the nature of the project and the clear separation made between the faculty's project and instructional responsibilities, it is not surprising that virtually all of the project's expenses accrue to the design and investment functions. Estimated life-times of the capital purchases are given in the footnotes to the table. In the project director's opinion, the content of the instructional materials themselves can be expected to remain as is with no further revisions for five years.

In the future, it appears that the operating costs of the courses themselves will be subject to few changes as a result of the materials and facilities created through the project. The only exception to this is in the area of computer services whose operating costs are expected to double compared to the pre-CAUSE cost of those services (from $3,096 to $6,910 per year).

Table 15

Direct Costs of Three Years

By Life-Cycle Function and Project Activity

FUNCTION	Objective One	Objective Two	Objective Three	Evaluation	Function Total
Design	$ 83,194	$ 10,366	$ 34,388	$ 8,953[e]	$136,901
Investment	17,549[a]	51,461[b]	17,347[c]		86,357
Operation			5,263[d]		5,263
TOTAL	$100,743	$ 61,827	$ 56,998	$8,953	$228,521[f]

[a] Instructional materials estimated to have five-year life.

[b] Facilities totaling $36,388 expected to have 25-year life. Lab and AV equipment totaling $15,073 expected to have five-year life.

[c] Computer equipment expected to have 10-year life.

[d] Cost for computer operation and maintenance.

[e] No attempt has been made to subdivide evaluation costs across design and operation function.

[f] Total does not include faculty replacement or indirect costs since these expenditures cannot be meaningfully attributed to the design, investment, or operation expenditures of any of the project activities.

DEVELOPMENT OF INSTRUCTIONAL COMPUTING MODULES BY A CONSORTIUM OF COLLEGES AND UNIVERSITIES

Site Visitors: Jane G. Cashell
Esther Lee Davenport
Richard M. Lent

Primary Author: Jane G. Cashell

Preface

This case study report describes a CAUSE project at the Computer Consortium for Higher Education Institutions which includes fourteen colleges and universities in proximity to each other. The project funded computer time and student programmer time so that faculty members could develop new instructional computing materials to accompany their courses. A process of evaluation and review of the modules which were proposed for development was instituted to insure that need for the modules was recognized by more than just one faculty member. The great challenge to the staff and faculty on this project has been working in a consortium setting across geographical distance and institutional differences.

The great challenge to the site visitors was to try to bridge those distances and differences in order to accurately describe this project. We interviewed twenty faculty members at ten institutions during three trips. We interviewed the first project director once and the current project director twice. We truly appreciate the cooperation we received from everyone who put up with a barrage of questions on a number of related topics during short time periods. We were treated most kindly and warmly by everyone and awarded the trust and confidence of people who did not know us.

The names of the colleges, the faculty and staff and the name of the consortium itself have been changed to protect everyone's right to privacy. Two nationally recognized and nationally available instructional computing projects have been identified by their real names - PLATO and CONDUIT. All other names are fictional.

Introduction

The Computer Consortium for Higher Education Institutions (CCHEI) has a three-year CAUSE project which began in the fall of 1977. The project was funded by NSF with $132,200 and by CCHEI for $68,935.

Four site visits were conducted over the period of a year during the second and third years of the CCHEI project. Jane G. Cashell and Esther Lee Davenport conducted three visits as a team. They visited the central office of CCHEI and one member college in May 1979. In December 1979 they visited six more consortium member institutions. In April 1980 they visited two more colleges and the central office again. Richard M. Lent also conducted a visit to the central office of CCHEI in April 1980. Telephone interviews were undertaken in order to collect additional data and to verify other data. Documentation and other materials from the project and from the institutions were reviewed between site visits.

The focus of these visits was to understand the project in more depth than was possible to do from the original proposal. We wanted to be able to describe to others in detail how the project operated and what it had accomplished. We were interested in finding out how the computer programs created for modules were being used at each campus, what process was used to develop the modules, and which other faculty members were making use of the modules. We also wanted to find out how the CAUSE project was perceived by faculty members at each member institution and, in general, how a consortium CAUSE project is implemented across physical distances. We felt that we could not get a good picture of this project unless we attempted to visit as many member institutions as possible. We did not think that study of this CAUSE project would be influenced very much by the passing of time and progress of the project because the proposal described what appeared to be development of a large number of modules similar in scope and limited in content.

Computer Consortium for Higher Education Institutions and the CAUSE Project

Background on CCHEI

The central office of the Computer Consortium for Higher Education Institutions is located in the computing center of one of the universities which participate in and sponsor the consortium. It is a college and university consortium for computing services and resources and serves as a network organization linking 14 higher education institutions to central computing facilities. CCHEI was established in July 1968 for the purpose of providing computer facilities to member schools for instructional and research purposes. Approximately $1.5 million has been provided by NSF for establishing and operating CCHEI over the last 11 years. CCHEI central is a small part (3 FTE, including 1.25 FTE on CAUSE) of the Computing Center at the University.

CCHEI provides member institutions with a number of services. Through the Computing Center, user consultants, program libraries, CAI and all instructional programs in the CCHEI library are available. CCHEI is also a member of CONDUIT because of its affiliation with the University where the consortium is housed. CONDUIT provides a large library of classroom-tested, transportable learning modules in a variety of disciplines. The purpose of CONDUIT is to study and test ways to stimulate the exchange of computer-based instructional materials for use in undergraduate education. Instructional packages from CONDUIT can be made available to member institutions through CCHEI. If two or more colleges are interested in a package it will be stored in CCHEI library space. If only one college wants the package CCHEI will still make it available, but the college must pay storage charges. All costs associated with CCHEI user services are covered by CCHEI's budget from the University. Member institutions are responsible for the cost of computer use time.

At the time of our visits to CCHEI and the member institutions, local computer resources and services appeared to be increasing and were being strengthened. Most of the members of the consortium have small computers to meet their academic computing needs. Many of them also have at least one microprocessor on campus, although sometimes it belongs to one department. Those colleges which do have their own academic computing services may still rely on their CCHEI hookup in order to do administrative computing. A few schools have given up their computing hookups with CCHEI altogether. The trend for member colleges to upgrade their own computer facilities seems very likely to continue.

Background on the CAUSE Project

According to the proposal, the CCHEI CAUSE project is aimed at improving and enlarging the library of computer-based instructional modules available for use in the sciences by member colleges and universities. The proposal describes a process for creation of new modules or improvement of existing ones. Student programmers, paid for their work, create the modules with guidance and assistance from faculty members. CCHEI central office provides technical assistance for the programming and also monitors the process of initiating and creating modules.

The CAUSE project director and assistant project director have their offices in the CCHEI central office. Their responsibilities include monitoring the system which selects modules to be created or improved and evaluates completed modules. Actual selection and evaluation of modules are accomplished by faculty members at CCHEI institutions. Publicity and information about the project and about modules completed and ready for use are provided by the CAUSE staff through visits to participating schools, a three- (now twice a year) issue-per-year newsletter, and content area workshops.

Implementation of the CAUSE Project

Once approval of the project was received from NSF, the first activity was the hiring of a project director. The director of CCHEI, who had prepared the CAUSE proposal, had been promoted to another position in the Computing Center by the time the project was funded. Several months at the beginning of the project lapsed with no project activity until a new project director and an assistant project director could be hired.

The project director and assistant project director began the CAUSE project and their work for CCHEI by traveling around visiting colleges in order to tell faculty members about the CAUSE project. All the faculty members who have participated in the project either met the project director or the assistant project director at a meeting on their own campus or were contacted directly by telephone. In several cases, CCHEI staff sought out faculty members in particular disciplines and suggested possible projects to them.

In order to participate in the CAUSE project, a faculty member at any college has to complete an application form to develop one or more modules. S/he has to describe what module(s) will be developed or revised and in what course(s) it will be used. The application form is then returned to the central office of CCHEI to the assistant project director who submits the application for review by faculty members in the same discipline or related discipline at other member colleges. These faculty members read the proposal and complete an evaluation form and recommend whether or not CAUSE funding should be given for module development. If no faculty member recommends the module for development, the application is denied. The evaluator of the application is encouraged to make suggestions which might improve the proposed module. (This process and the accompnaying evaluation forms are similar to those used on a similar project and were developed and revised based on years of heavy use.)

The intent of the CAUSE project plan is that a faculty member will have a module to be programmed and a student who wants to be employed to be the programmer. For each completed module the student receives $200. In programming a module the student is encouraged to use authoring guidelines and BASIC or FORTRAN as recommended by CCHEI. Once a project gets underway, CCHEI is not likely to have much interaction with the student directly. Rather, it is the responsibility of the faculty member to work directly with the student programmer. The students are free to call and ask for advice, but very few make use of this service on their own initiative. If help is needed, the faculty member usually serves as liaison to CCHEI. Students are paid one-third of their fee when a project is half done and the rest when a project is completely finished and has passed final evaluation. Faculty members are not reimbursed for their time or involvement and no release time or replacement instructors are available to them if they participate in the CAUSE project.

Once a module is complete, it is sent to CCHEI where the staff adjusts commands and conducts test runs to see that it works as intended. The CCHEI secretary types the documentation which accompanies the module and places it in the CCHEI library. The module is then sent out to be evaluated by a faculty member at another college, sometimes to the faculty member who evaluated the original application. The faculty member reviews the module and recommends changes, corrections, or improvements.

Once a module is complete, it is announced in the CCHEI newsletter which goes to faculty members participating in the CAUSE project and to other staff and faculty of each member institution; for example, computing center coordinators.

The original proposal for the project planned for four workshops to be conducted each of the three years of the project. The purpose of these is to share information about modules among the faculty members in the same discipline across CCHEI. The first year two workshops were held. More workshops will be given but they have been scheduled for the last year of the project when the modules are finished being developed.

The original goal of the CCHEI project as stated in the proposal was to redesign or create 120 modules. To date, at the time of the last site visit, 58 modules had been completed or were underway. The completed modules are listed below by institution and include the faculty member's discipline, title of the instructional package (may be more than one module), and a short description of the package provided by CCHEI or the faculty member.

Red Maple College

Numerical Analysis, Mathematics (two modules)

This 13-program package in undergraduate numerical analysis is designed to be used for sophomore through senior students. Assumed prerequisites include two terms of calculus. It includes such procedures as Herner's method of evaluating a polynomial at a given point, Simpson's methods to approximate an integral, and Cubic Spline Interpolation to approximate a function.

Oak College

Counselor-Client Simulation, Psychology (one module)

This psychology counseling simulation is designed to assist in the teaching of counseling skills.

Solving Equations, Mathematics (two modules)

This program offers computer-aided algebra, drill and practice, and quizzes for the pre-calculus mathematics student.

Instructional Statistics, Statistics (five modules)

This set of 35 programs in pre-calculus and mathematical statistics is designed to facilitate statistical computation and illustrate such concepts as sampling distributions, confidence intervals and various types of probabilistics notions.

1976 Election Study Instructional Subset, Political Science (two modules)

This subset uses data drawn from the 1976 Center for Political Studies data set and simplified in a manner similar to the 1972 SETUPS (Supplementary Empirical Teaching Units in Political Science) packages.

CLAS1, A simulation of the Rescorla-Wagner Model of Conditioning, Psycology (one module)

CLAS1 was designed to simulate predictions generated by the original Rescorla-Wagner model, which was designed to account for experimental data derived from compound-stimulus conditioning situations.

Ash College

Equilibrium Calculations, Chemistry (one module)

This general chemistry program is to provide drill and practice in solving equilibrium problems.

Physics Laboratory Analysis Programs, Physics (one module)

This is a conversion from batch to interactive and covers such concepts as analysis of measurement data, least squares analysis, simple harmonic motion analysis and projectile motion.

Beech College

Interactive BASIC Version of IDGAME, Chemistry (one module)

This is a revision of a CONDUIT batch program. It is an organic chemistry qualitative analysis simulation.

Additional Compounds for the Interactive Version of IDGAME, Chemistry (one module)

Five additional unknowns have been added to the interactive organic chemistry qualitative analysis simulation.

Student Use of General Social Survey, Sociology (one module)

A subset of the General Social Survey has been selected, and a codebook and documentation have been written. This provides a manageable subset for student use through SPSS (Statistical Package for the Social Sciences).

Aspen College

Lens System Simulation, Physics (one module)

This physics program simulates the formation of an image by a simple positive lens and gives graphics output on either a hard-copy terminal or a CRT.

Student Manuals - SPSS for use with SETUPS, Political Science (one module).

These manuals were developed to assist students in the use of two of the SETUPS (Supplementary Empirical Teaching Units in Political Science) packages -- The Dynamics of Political Budgeting and The Supreme Court in American Politics.

Pine College

C Double Bond C, Chemistry (one module)

This organic chemistry simulation and drill is designed to develop familiarity with possible double bond reactions and reagents.

The University

Colonial America, Political Science (one module)

This study of past populations, particularly in colonial America, was approved for CAUSE funding but was completed without the need for CAUSE support. Further documentation is available through the Laboratory for Political Research at the University.

Process Design and Evaluation, Chemistry (one module)

This computer simulation for chemical process design will allow the student to study the effects of design variables such as pressure, temperature and recycle rations on the overall process profitability.

Voting Behavior in the U.S. 1952-1976, Political Science (one module)

This is an update of a CONDUIT package by Dr. G. R. Boynton, Voting Behavior in the U.S., 1952-1972, with the addition of the 1976 election data. This package is available through CONDUIT.

The following modules are still being developed.

Poplar College

EXPERISM:MESS Model, Psychology (one module)

This model studies transitivity learning in children.

Locust College

Trigonometric Tutorial, Mathematics (one module)

This is to allow students to review trigonometry out of class.

Five Biology Simulations, Biology (five modules)

These simulations cover the following topics: energy flow in a lake ecosystem; enzyme kinetics; chemical basis of heredity; population genetics; and population growth and logistic equation.

Oak College

Cluster Analysis, Anthropology (seven modules)

This multi-disciplinary package is designed to explore the conceptual problems of classification common to all sciences and to provide a tool for analyzing course-related data.

Experimental Control in Verbal Learning, Psychology (three modules)

These will be experimental control and data analysis packages within the general experimental paradigms of paired-associate learning, serial learning and free recall.

Congressional Behavior, Political Science (one module)

This nearly completed instructional data package focuses on Congress, political representation and campaign behavior.

Contemporary Learning Models, Psychology (two modules)

The topic of the first module is Sperling's model of visual short term memory and of the second module is models of choice behavior, compatible with Hernstein's matching law.

Chestnut College

Additional Compounds for IDGAME, Chemistry (three modules)

Three new compounds are being added to the unknown file of the CONDUIT Batch organic chemistry identification game, IDGAME.

Pine College

KEMATH, Chemistry (one module)

This is an out-of-class drill for science students to "brush up" on logs/anti-logs, percentages, powers, roots and exponential notation.

RS, Chemistry (one module)

This is to improve, by better documentation, a chemistry program which provides drill and practice on the assignment of R/S configuration from a molecular structure.

Aspen College

Wave Dispersion Simulation, Physics (one module)

This is a simulation for physics of the time-dependent behavior of several types of waveforms to demonstrate their propagation characteristics.

Stellar Video Scan, Physics (one module)

This program is to provide an expandable data base for computations and correlations.

The University

Variable Concept, Mathematics (one module)

This is a mathematics tutorial/drill program to introduce the concept of a variable and then to develop techniques of variable manipulation.

The site visit team went to almost all of the contributing institutions including one which is part of CCHEI but where no faculty member has participated in the CAUSE project. Each faculty member interviewed was asked to describe the content and purpose of his/her module, the process by which it was developed, how s/he heard about the CAUSE project, and other related CCHEI activities. The objective of these visits was to learn about the modules from their authors, to find out about the involvement of CAUSE faculty members in the project, and to understand how the institutions work together in the consortium arrangement.

May, 1979 - First Visit to CCHEI

CCHEI central office. We first visited the CCHEI CAUSE project in the spring of 1979, when the project was approximately midway through its second year. We met first with CAUSE staff in the central office of CCHEI at the University. Then we visited Oak College and interviewed CAUSE faculty members there.

We understood from the proposal that a large number of instructional modules would be developed and programmed as the goal of this project. The proposal described that students would do the programming, that faculty members at any consortium institution could apply to participate in the project, and that a system of peer review and evaluation forms already existed and would be adapted for use on the project. From looking at the proposal budget we learned that students would be paid for their work on the project but faculty members would not. The proposal also described some activities, workshops and a newsletter designed to spread information about the project throughout CCHEI.

We met with the project director and assistant project director on our first visit in order to find out more detail about how the project worked. They told us that a faculty member had to initiate module development, although they, CCHEI staff, played an active role in encouraging faculty to do so. The faculty member had to pick a topic or topics which could be taught effectively using the computer. These topics needed to be "small" - not too complicated conceptually and not requiring too much time for the student to study it. A faculty member could choose a larger topic and break it into pieces or could choose to create programs for a number of related topics. However, each program was to be short and was designated as a "module" for CAUSE project purposes.

Once a faculty member had an idea for a module s/he had to fill out an application to develop it as part of the CAUSE project. The completed application was sent by the central CCHEI staff to two or three faculty members at other colleges for their review. The reviewers were chosen because they are the senior faculty members in their disciplines at their institutions and also in the consortium. They are well-respected by their colleagues. Their task in reviewing applications was to evaluate the content, the instructional uses of the module, and whether or not the module would be of use in their own classes. If a module application got a favorable review but was not of interest to another faculty member then CCHEI central staff denied the request for development. The reason for this decision was that the CAUSE project is a consortium project and modules created with its funds must be judged useful on a consortium-wide basis and not just useful to one institution.

The project director and assistant project director also described activities undertaken to publicize the CAUSE project. The consortium newsletter first announced the availability of CAUSE project funds for module programming. Then the CCHEI central office staff visited every college in the consortium during a short period of time at the beginning of the project. Each college has a person who serves as consortium coordinator. This person and any computing staff at each college were notified of the CCHEI staff visit. Meetings were held on each campus and either CCHEI staff or the campus coordinator invited faculty members to attend to learn about the CAUSE project. The project director and assistant project director telephoned faculty members directly if they knew of someone in particular who might be especially interested in the project.

In some cases the CCHEI staff asked faculty members if they would be interested in revising or adding to a module already in the CCHEI library. It was not the intention of this CAUSE project to program only new modules. Upgrading of existing modules to make them more useful consortium-wide has also been considered an important objective.

At the time of our first visit the development of many modules had been started. We got a list of faculty members, colleges, and module topics from CCHEI. We asked if project implementation had gone as intended. The project director and assistant project director said that the project was going along as expected. They had received feedback from several faculty members that module development required a great deal of faculty time. The CCHEI staff felt that at times faculty participation in module development was low because faculty members did not have time allocated in their schedules to prepare modules. They believed that provision of a student programmer certainly did motivate some faculty members to become involved in instructional computing but that lack of release time for the faculty themselves was a deterrent.

Oak College. During this visit to CCHEI we went to Oak College. Oak is a small private residential college founded in 1846. It offers a bachelor's degree in many fields, and a majority of its graduates go to graduate school. It has a strong tradition and reputation for excellence in teaching. Oak College's student body is drawn from all across the country. The college takes pride in the fact that a high percentage of its graduates have experience in computing. Many learn at least one programming language. Oak College has its own PDP 11/70 and retains a hookup with CCHEI for batch process computing services.

We were able to interview six of the seven faculty members who were developing CAUSE modules. The seventh faculty member had just begun the process of applying for a module to be programmed so we chose not to interview her.

First we met the head of academic computing. His responsibilities include promoting instructional computing, encouraging the faculty to use the computer facilities, and tracking down special equipment or software needed by a faculty member. He also teaches statistics. He has developed five modules for the CAUSE project.

We asked about his experience in developing modules. He said he had difficulty predicting the amount of time necessary to program a module. He didn't know how much work would or should match the $200 per module fee paid by CCHEI to the student programmer. However, he did not think that students should have been paid on an hourly basis because of differences in individuals' programming skills. He noted that he believes that the opportunity to program a module can have educational value for most students. He told us that in addition to designing the modules and monitoring the student who programmed them that he had to spend about 100 hours making the modules match CCHEI and the University's specification. He explained that his modules were programmed on the Oak College PDP 11/70 and then had to be adapted in order to be transportable to the University's system which is CCHEI's computing facility.

He told us that he has worked to publicize computing on campus and to promote the CAUSE project because there is money available for faculty to get programming done. He believes that the modules can improve the educational value of the courses in which they are used; a good reason, in his view, for being enthusiastic about the CAUSE project. He did tell us that he thought his student programmers had to wait too long to get paid.

When we asked him to estimate the impact of the CAUSE project on instruction, he said that was difficult to do because academic computing had grown so rapidly both at Oak College and around the consortium. The rapidly decreasing hardware costs make it difficult for him to separate the effects of CAUSE from the general effects of an increase of instructional computing.

Next we met a faculty member in psychology who had been working on development of three modules on verbal learning. His objective for use of the modules is to enable students to do on-line experimentation in paired associate learning, serial learning, and free recall learning. His course has been set up so that students actually conduct the experiment on line, and when they do so they use a great deal of computer time and tie up the Oak College system for a long time. The new modules are designed to help alleviate these problems.

The psychology faculty member told us that he had difficulties getting the modules completed because of lack of qualified student programmers. Eventually he found a student who did complete the programming. Now it is his responsibility to complete the documentation but he has not had the time to do so. He hoped to finish the modules during the summer but noted that he will not be paid by CAUSE for the time he had to put in.

We interviewed another faculty member in psychology who has developed modules for the CAUSE project. Her three modules are intended to create simulations of models or experiments studied in her course on learning. The equipment to conduct the actual experiments is not available in the lab at Oak. The students are required to conduct laboratory experiments but expansion of the laboratory portion of her course is prohibited by lack of time and money.

She applied to develop three modules which will deal with a contemporary model of learning and one has already been completed. She chose to develop computer modules based on her experience teaching the learning model from the textbook which she found was too difficult for students to read and to understand. The computer simulation of the learning model forces students to change experimental parameters and to manipulate the model under a number of different conditions.

The student programmer for the module joined in our discussion of the actual programming of the completed module. The psychology faculty member said that she did not know much about programming and had assumed that the student understood more than he did about the content of the module. The complexity of the learning model and the difficulty in designing an instructional module around it were greater than she had expected. In the end, she was responsible for designing the content of the module and then for working with the student programmer for many hours to program it.

The student programmer told us that he began by studying the programming guidelines from CCHEI and discovered that the simple form of BASIC required by the guidelines was difficult to work with. He did the programming on the Oak College computer and found that the basic BASIC took a long time to turn around on the Oak system. He stopped using the CCHEI guidelines for BASIC and used BASIC Plus, the language of the Oak system. He had to reprogram the module to make it transportable to the University system for CCHEI. The faculty member told us she felt that the student had actually written two modules but only received pay for doing one. They said that neither of them realized at the beginning how complicated it would be to make the module available for both computing facilities.

The faculty member said that she had had this idea for creating a simulation of the learning model, but she would not have undertaken it if the CAUSE money for programming help had not been available. She said she thought perhaps eventually she would have gotten around to creating the simulation but that the CAUSE money was a definite impetus for her undertaking the creation of the module at the time that she did.

She said she thought it was not unreasonable to require that a version of the module be available to CCHEI since the CAUSE project provided the money for programming, but she felt that CCHEI should cover programming of two versions of the module, one for CCHEI and one for Oak.

The psychology faculty member noted that her module is the first in the psychology library of CCHEI, that it was reviewed by other faculty members in the consortium, and that several of them were interested in it. She has sent a tape of the module directly to another college which also has a PDP 11/70. It seemed to us that her module is being used and has been recognized as being useful by other faculty members in psychology.

Next we spoke with a faculty member in anthropology. He told us that he heard about the CAUSE project from some flyers or announcements from CCHEI and attended a meeting where the assistant project director explained the CAUSE project. It was his understanding that the CAUSE funds were available for any instructional computing purposes and that the programs created with CAUSE funds were to be usable throughout the consortium.

The anthropologist said that he had a complex topic, cluster analysis, that he wanted to teach utilizing instructional computing. When he learned that programming was paid for in $200 allotments to be equal to one module, he divided his topic into modules for the purposes of funding and programming. He said he had difficulty estimating the amount of programming involved and that he underestimated it.

He told us that his motivation for creation of the modules was that cluster analysis is not available to a wide variety of users. Publications on cluster analysis are theoretical and written at the advanced research or graduate student level. He said he wanted to use cluster analysis with his undergraduate students so he tried to create user-oriented computing materials. He decided that the instructional modules would have to be interactive for students to be able to learn cluster analysis. He checked out other statistical computer packages and found that most of them did not include cluster analysis or, if they did, that the documentation was so poor that the programs were very difficult to use.

The anthropologist sent his application in to be evaluated and said it came back very quickly. His application was reviewed by a sociologist and two biologists and received favorable comments. He said that he thought it a good idea to require modules be usable either at Oak College or the University. He had already sent an earlier version of his modules to another consortium.

The faculty member realized after the programming had begun that the programs he wanted were too fancy. His goal had been to create very flexible programs. He said the programmer who worked on his modules had done an excellent job and had done more work than that for which she was paid. Although she has transferred from Oak College to the University to major in computer science, she has continued to work on the modules with a tie-in from the University to the Oak system. The anthropology faculty member said that he felt that probably the scope of his project is too large to handle in a limited period of time. He said if he had had the average student programmer his projects would have been way behind schedule. The student has been able to renegotiate part of her programming contract with CCHEI in order to get more money than was originally arranged.

The faculty member told us that there simply isn't any money available at Oak to support programming for instructional computing, and that the CAUSE money enabled him to undertake the development of these modules. He also said that he believed it was a real advantage to the consortium that if one faculty member was interested in a particular subject that that person would get it going, and then others could use it later. The anthropology faculty member was not familiar with other CCHEI modules. He mentioned other CAUSE modules developed at Oak. He said he could keep up with this if he received the CCHEI newsletter, but that somehow he hadn't received the newsletter because he didn't manage to get his name on the subscription list.

One thing that the faculty member felt was important to describe to us was the involvement he had had with other faculty at Oak since the creation of the cluster analysis modules. He pointed out that four departments - sociology, psychology, biology and anthropology are using the modules. He also said that it started the faculty of those departments talking about the problems of instruction and the problems of using the computer for instructional purposes. However, he does not believe that his work on instructional computing will contribute to his promotion or tenure.

A faculty member in political science is teaching an entry level course in which students study the elections and the election process. In order to give students exposure to current election data, he used CAUSE money to have student programmers simplify sets of the data from the 1976 elections. He told us that making modules transportable to CCHEI added to the work of students and added to his own work because of increased need for extensive documentation. However, he has initiated development of a second module.

The political science faculty member expressed some dissatisfaction with the way in which the process of developing modules works. The student who worked on his first module had not completed the module. He said he believes he has no control over when the module is completed because the programming contract is actually between CCHEI and the student. Also the CAUSE module evaluation takes too much time to test the modules and get them up on the University system. The faculty member told us that the CAUSE project used a lot of his time and in order for him to do a really good job on the modules he should have been released from some other obligations. He said if CAUSE money had paid for release time he would either have finished the modules earlier or not undertaken to develop them at all. He said perhaps he underestimated the time the project would take because he thought of it as a "back pocket" project.

A faculty member in mathematics whom we interviewed has four modules completed or under development. He said that he had just gotten a LOCI grant from NSF to develop more modules similar to the ones that he began to develop under CAUSE funding. He got started with the idea of developing instructional modules for pre-calculus when he went to visit the PLATO project. After that, he developed a small module called EQUATE which allows students to practice and review their algebra equations. He described it as flexible and adaptable to students' abilities. He has conducted a study with EQUATE in which the module was tested on pre-calculus students with one group of students receiving algebra practice while another group received no opportunity to practice. Students who used the EQUATE module did better in pre-calculus on the final exam than those who did not. All this work was done by the mathematics faculty member on his own with no financial support from the CAUSE project.

He then applied to CCHEI to develop additional modules for pre-calculus. He found out about the CAUSE project from the Academic Computing Coordination Center and applied for funds to revise the EQUATE program and to rewrite it for the University system. He also applied for three new modules for pre-calculus students to practice equations and graphic representation of equations.

He has hired a student for the entire summer to do the programming on these three modules. One of the three modules is funded as if it is two modules so the student programmer will receive $400 for it. The faculty member expressed some concern over the amount of time it takes to get a student paid. Work handed in at the end of the summer to CCHEI has to be evaluated and tested on the University computing system. He felt, if a student is to work during the summer, the student really should be paid at intervals throughout that period.

The faculty member talked to us about what he considers to be a very important issue in instructional computing--the establishment of standards for high quality work and the establishment of rules and programming guidelines for transportability. He believes this is the only way instructional computing can be promoted and furthered in the future.

Results of the First Visit

After we visited Oak College we had an opportunity to go back to the CCHEI central office and speak further with the project director and assistant project director. We asked questions and discussed our impressions of the project. We were very aware that our impressions were based on information gathered only at one member institution and were concerned that we had gotten a view of the project only from the perspective of Oak faculty.

Several issues related to project implementation and impact seemed to us to be worth pursuing further to see how important they might be. The first issue is one of computing facilities in the consortium. We had assumed, albeit naively, that the member institutions relied exclusively on the CCHEI for any access to computing facilities. We had not thought about the fact that computer technology has been subject to dramatic changes in size, cost, and availability of hardware. Before arriving at CCHEI we had not considered the possibility that member institutions would be so likely to have minicomputers and microprocessors. We thought they would still be heavily involved in time-sharing computer facilities (of the University).

The fact that Oak uses its minicomputer for a majority of its academic computing needs has influenced the CAUSE project. It has meant that the programming could be accomplished far more conveniently on the Oak system than it could using the CCHEI hookup to the university. Oak only has one interactive terminal with the University system. If batch access with the University is needed, the terminal is inoperable. Use of the University system is also expensive for Oak since the college must pay for telephone fees for the hookup time. The result of Oak's having its own computing facilities is that CAUSE-funded modules end up being programmed on the Oak computer and reprogrammed for CCHEI. Need for a two-stage process received a great deal of comment from the Oak faculty members participating in CAUSE, even though they all support the idea that their modules should be available consortium-wide.

The second issue we thought we observed from our interviews at Oak was the one of faculty involvement in the project. Everyone we interviewed commented on the amount of time required to program a module. For them, module development conflicted with many other responsibilities which they also have. All the faculty members are very interested in computing and are motivated to create better learning opportunities for their students. However, apparently at Oak there is no recognition of improving a course as a professional activity to be considered toward promotion and tenure. So developing a CAUSE module competes with many other responsibilities and is not recognized as an important activity.

We also heard a variety of different comments on use of student programmers, recruiting them, directing them and getting them paid. It seemed to us that there were not any clear trends in the comments. Rather, it seemed that successful completion of a module was dependent on the programming skills of the student and the development and management skills of the faculty member. Both people need to be persistent.

We established questions for one next visit to CCHEI to focus on gathering more information on development of modules, interaction with CCHEI central office, and communication around the consortium about the CAUSE modules. We also decided to investigate further the issues of transportability of modules and release time for faculty members. We were concerned that these might only be issues at Oak College, although based on our discussions with the project director and assistant project director, we thought not.

December, 1979 - Second Visit

Ash College. The next visit was in December, 1979 to Ash College, a private Catholic college with 1700 students in the liberal arts, business, and sciences. It was founded in 1839. (Ash College has recently received a separate $250,000 CAUSE grant related to the educational use of computers.) The college is one of the original members of CCHEI and is still tied in by phone. Ash has a line printer, a card reader, interactive terminals, and a Prime computer of its own.

We first met with a faculty member in physics and astronomy. He proposed to CCHEI to convert the existing batch programs used in physics labs to interactive mode. Instead of the students having to key punch and submit a card deck and wait for printed output, the student can specify his program and parameters on a typewriter-like terminal and view the output nearly immediately on a video display. The physics professor's programs were designed primarily for use in beginning physics lab. They included two projectile programs, one each on refractive index, least squares and vectors. The vector program was written especially for the CAUSE project, while the others were already in existence in batch mode. The student who did the programming was at the time taking a FORTRAN course. The student met with the physics faculty member once a week until the module was completed. No particular problems were encountered by either the student or the faculty member.

The second faculty member we visited at Ash was a chemistry faculty member. He has used the CCHEI tie-in for extensive chemistry calculations for some time, and has reviewed 20 chemistry programs in the CCHEI library. Six of these are now available on the Prime at Ash College. One of these programs provides drill in solving equilibrium problems in chemistry. The chemistry professor decided that this program was unsatisfactory--primarily because the program jumped from problem to answer without showing the student the steps involved in obtaining the correct answer. His proposal for CAUSE funds was to have one of his chemistry students add the steps of solving the problems to the program.

We asked the faculty member about his use of the computer for instructional purposes. He said he cannot require the use of the computer in his classes due to equipment limitations. He provides instructions to students in the use of the computer and estimates that about ten percent of his students make use of facilities and available programs on their own. For him, computer packages provide opportunities for individualized drill to his students and he is enthusiastic about using CAUSE funds to improve existing drill programs. If student programming funds had been unavailable he would have waited until he had a lighter teaching load in order to do the programming himself. He commented that the project has taken much more of his time than he expected.

We also visited a faculty member in biology at Ash College. We asked to interview him because, although he has not developed modules, he has served as a CCHEI reviewer of proposals for module development. He has, in the past, written programs which are available through CCHEI. We asked him why he has not participated in module development using CAUSE funds for a programmer. He described his own participation as minimal because he has not had the right student, one interested both in biology and programming, and he has had no time available. He pointed out that even if there had been money for faculty release time he still wouldn't have been able to shift his teaching loads except in summer.

One of the strong points of the CAUSE grant, according to the biologist, is its focus on small programming projects--an approach analogous to the Freman Press off-print series which provides a single experiment or lesson from which a teacher can draw and add to his own course. CONDUIT, for example, he said sponsors only programs which provide the equivalent of a whole course's worth of instruction, but faculty members prefer to structure their own courses.

Mimosa College. We left Ash College to seek out the CCHEI coordinator at Mimosa College, a few blocks away. Mimosa was founded in 1843 and was for many years a women's college. The college is now co-educational with strong programs in music, art, and computer science. The purpose for our visit to Mimosa was similar to that for our visit to the biologist at Ash: we wanted to know why the faculty and staff at the college have chosen not to participate in the CAUSE project. The coordinator received us most cordially and seemed interested in giving us both an overview of Mimosa College's activities in educational computing and her opinions on why there has been no interest in the CAUSE project.

The two topics are not unrelated, she believes, because "interactivity is the essence of educational computing." Based on that notion, she has done considerable investigation into the most economical possible solutions to the problem of providing large amounts of computing time to many students. She has chosen stand-alone microprocessors as the solution and has aimed at creating mini-micro computer labs for all educational computing purposes. Mimosa has already acquired a micro-lab which is used extensively for ear training in music. The college has also been given an IBM 360-40 machine which handles most of administrative computing. The math and chemistry departments have mini computers and make some use of CONDUIT packages on these.

As a result of all these activities, the hookup to CCHEI for interactive computing was not used and has been removed. The coordinator would like to re-establish communication using the micro processors as the basis. There is, apparently, a system available for occasional micro hookup to CCHEI which would be less expensive than the permanent telephone tie-in to the University system.

The second topic discussed in our interview with the coordinator partially explains the first. That is, educational computing capability at Mimosa has been oriented to on-site machines so that development of transportable modules for CAUSE is not of interest to the faculty. Participation has also been affected by the unavailability of student programmers. According to the coordinator, students can get programming jobs with a local company that pays very well.

Chestnut College. Our first interview the next morning was with a chemistry professor and his student programmer at Chestnut College. Chestnut -- whose motto is "Goodness, Truth, Beauty" -- has fewer than 1,000 students, mostly women, mostly commuters. It offers a variety of majors; education and nursing are considered the strongest areas. Chestnut College obtains all its computing services, both academic and administrative, from CCHEI via hookup to the University.

The faculty member's project is to supplement an existing program - IDGAME - which simulates an organic chemistry laboratory. The program is a batch program in which a student with a budget limit selects various tests until she can identify a mystery compound. Ideally, according to the chemistry professsor, the program would have 200 compounds requiring tests ranging from simple to very difficult to solve. At the present, the program only has 20 compounds and the difficulty range of these is not wide. Many are too simple; a few are too difficult for the students to solve. The value in the program is that it permits students practice with results from tests requiring very expensive equipment which is unavailable at most small colleges. The student programmer has done library research to find several compounds to add to the 20 that exist.

The faculty member told us the CAUSE project met a local need. The student had decided to develop the module anyway; the CAUSE funds provided her a welcome incentive. The chemist is also very positive about the value of the CAUSE grant. He noted that he had spent considerable time himself doing research for the module, but had no objections to that. He did not see any aspect of the structure of the CAUSE project procedures as a drawback to his participation.

Aspen College. Our next two interviews were at Aspen College, a few blocks away from Chestnut College. Aspen College was founded in 1882, and has about 1,600 students, 1,000 of whom commute. Forty percent of their students are in business; 20 percent in the sciences--most in biology or computer science. The school has lacked a stable computer configuration and regular access to a computing facility for faculty and students. At the time of our visit, the college had one interactive terminal hooked to CCHEI and intends to buy eight more. CCHEI library programs are being used. The science department has built a microprocessor for use only in physics and engineering classes. A physics faculty member and an engineering faculty member are responsible for the microprocessor, and these are the faculty members with whom we met.

The physics professor is also director of academic computing at Aspen. He learned of the CAUSE grant through the CCHEI newsletter. He and his student created a program which simulates the formation of an image by a simple positive lens and gives graphics output on either a hard-copy terminal or a CRT. The module is complete and now in use. He is working on another program to simulate wave action.

The engineering professor serves as the computer operations coordinator in the science department, and has had a rather different experience. He has proposed an ambitious project to graphically simulate certain constellations and their motions. The project has been tremendously demanding of his own time; and his experience with student programmers has been very discouraging. The students have not been reliable and the module is unfinished.

Poplar College. Our final visit of the day was Poplar College. Poplar is Lutheran-affiliated, was founded in 1860, and has approximately 2200 students. The college has a PDP 11/70 computer. One module has been developed by a psychology faculty member who has since left the college. Our visit on December 4 was with a sociology faculty member who is the academic computer coordinator at the college.

Although not the designated CCHEI campus coordinator, the sociology professor stays in close touch with CCHEI staff. He gets the CCHEI newsletter and gave us the most up-to-date listing of modules being developed on the CAUSE grant. He has visited most of the colleges in the consortium and was formerly employed at Oak College as computer coordinator. As these activities suggest, he believes in the value of instructional computing and actively promotes it in all departments at Poplar College. He told us that the college determined never to sever ties with CCHEI because the special languages and expertise available from CCHEI are valuable even as Poplar's own capabilities and facilities increase.

We asked the reason for the absence of other projects on a campus where computer use is being fostered so aggressively. The sociology professor cited several drawbacks of the CAUSE project, as well as certain characteristics of the college which worked against their participation. Contending with transportability is a drawback. Getting a student to write a program twice or to write in basic BASIC are problems. A second drawback is demand on faculty time, and Poplar is on a quarter system which, the sociologist believes, cuts faculty time into too many little segments. He believes that faculty supervision is extremely important to successful projects, and therefore faculty members need to commit a significant portion of time to module development.

According to the faculty member, other factors influencing CAUSE participation at Poplar include the existence of college funds to support instructional programming. Recently, the Lutheran church provided nine faculty members with $900 each to write programs and adapt courses to include computer use. The CAUSE funds are not in demand even though many students have programming skills, and most students have at least been exposed to computers.

Beech College. The next day we visited Beech College, founded in 1859 by the Franciscan Order. Beech has about 1,650 students divided evenly between men and women. We interviewed three faculty members here, two who were working on projects and one whose project had been rejected.

A professor of chemistry at Beech became involved in the CAUSE project even though, at the time, he knew nothing about computers. The assistant CAUSE project director asked if he would find a student programmer to switch the IDGAME program from batch to interactive and to write it in BASIC. He found a student programmer and monitored the project. He has used IDGAME in his organic analysis course and still uses it but in the batch mode. He has proposed and had approved a second module--to expand IDGAME to include more chemical compounds. He and another student programmer have nearly finished the research to add five compounds. These compounds are intermediate in difficulty to identify and new in compound type. He has spent considerable time himself on the project. He believes the project is a valuable one and notes that it certainly has helped a needy student.

Over lunch in the Friary, we interviewed a student programmer and a faculty member in sociology. The faculty member applied to use CAUSE funds to create a limited data base from the General Social Survey. He told us such a base is more suitable for undergraduates. The complete General Social Survey data base is complicated and cumbersome to use, even on the computer. A limited number of variables has been selected for a five-year period. In the case of this module the student did not actually write a program, but rather used an existing program (SPSS) to reduce the size of a data base and make it accessible for classroom use. Educational documentation for this project--definition of variables--was nearly complete at the time of our visit.

We asked both faculty members if they had any suggestions for improving the CAUSE project. The sociologist thought that if student involvement could be associated with granting credit in a specific course as a project or independent study perhaps there would be more motivation for faculty to become involved. The chemist told us that he thinks faculty generally need more encouragement to use the computer. He suggested a summer institute for faculty to study educational computing applications in their own discipline.

Our final interview of the trip was with a professor of mathematics and computer science. He has a number of students who would like to develop modules and, in fact, he has proposed and carried out one -- a program to teach PL/C to beginners. This program, done entirely by the student, received negative evaluations and has not been included in the CCHEI library. The faculty member also proposed a similar project to write modules to teach COBOL to beginners, but this application was rejected. He is not sure about the evaluators' objections to the student's work, but feels it may be related to the fact that the reviewers' backgrounds were mainly in computer science. Such specialists, he felt, might not appreciate the very simple approach necessary to teach naive students a programming language. He also observed that there is very little incentive for faculty participation in the grant.

Results of the Second Visit

At the end of our second visit we analyzed our findings from the visit and then compared them to the first visit. Need for the modules to be transportable was still an issue of concern to faculty members involved in or considering involvement in module development. The fact that almost all the colleges we visited had academic computing facilities on campus meant that most modules had been programmed to run on a local system. However, frustration over having to program a module twice - once for the college and once for CCHEI - was less pronounced at most of the colleges than at Oak.

The issue of amount of faculty time consumed by module development was just as important, and perhaps more so, at many colleges other than Oak. It is possible that, because instructional computing is a commonplace activity at Oak, faculty there are more willing to spend time on it for their courses. Oak has seven faculty members developing modules while no college on our second visit had more than three involved. It is ironic that at Oak, where developing and programming instructional computing for use in courses are frequent activities, such activity is not counted in promotion and tenure decisions. At the other colleges we visited faculty rewards are more likely to be for teaching than research and publications. Yet these colleges have fewer faculty members involved in developing instructional computing which is a teaching-oriented activity.

Another issue appeared during our second visit which was not important at Oak College, and that is consortium communications. Computing is a wide-spread and high-interest activity at Oak College. The college is also located close to the CCHEI central office. The Oak faculty is well aware of the CAUSE project and other CCHEI activities and resources. At the next six colleges we visited, the faculty members we met were informed of CCHEI activities in varying degrees. Some were very up-to-date. Others were less well informed. Some claimed not to get the CCHEI newsletter. Others said they did but were not sure that they still received it. Only one faculty member seemed clear about the fact that the newsletter changed from being published three times a year to twice a year. A few faculty members were not sure if there were CCHEI guidelines for developing, programming and documenting modules. Two faculty members expressed considerable frustration over the module development but neither of them had initiated direct contact with CCHEI staff to see if they could help solve some of the faculty members' problems.

A fourth issue we considered is need for the CAUSE project. On the campus where modules are being developed no other resources are available to faculty for programming. At Mimosa and Poplar, involvement in CAUSE is very low level but local resources to support faculty in programming are more readily available. Many faculty members volunteered that they would not have been able to create their modules if CAUSE funds had not paid for student programmers. In a few cases the attraction of being able to hire a student programmer was enough to get a faculty member involved. In a few other cases it was not enough.

April 1980 - Third Visit to CCHEI.

Pine College. The first stop on our next trip was at Pine College. Pine was founded in 1860 and is affiliated with the Methodist church. The student body is coeducational and numbers approximately 850. The strong academic programs are music, education, and business. Most students taking science are pre-health majors. Pine has its own computer, an HP2000, and maintains a tie-in to CCHEI for administrative computing. Purchase of a new computer for Pine is being seriously considered.

We met with a faculty member in chemistry who has been heavily involved in instructional computing in chemistry for years. He has written or adapted over 45 programs for use in his courses. He applied for money for students to prepare documentation for four modules that he had already created. However, since he wasn't sure if CAUSE funds could be used in this he didn't apply until after the CAUSE project was well underway. One module was not funded because the reviewers judged it to not be of interest to other faculty in the consortium. Two were complete at the time of our visit; one of those was in the review and evaluation phase. The last module is still being worked on.

To get the modules completed the faculty member met with his programmers and told them about programming guidelines and worked out a plan for programming with them. (Each module actually includes more than one program.) Then he told them what he expected from them in terms of documentation. They worked by themselves. Once they had a first draft finished, the chemistry professor critiqued it. Since these students were creating documentation they were primarily involved in writing, not programming. One student, a chemistry major, arranged with the chemistry professor to prepare the documentation as a project for his developmental writing course.

The faculty member uses the modules in his introductory and organic chemistry courses. One module, Kemath, is a review of math skills used frequently in chemistry. The other modules C Double Bond C and RS, are used in organic chemistry as drill and practice for understanding bonding and molecular structure. All of these modules are used as supplementary instruction in his courses. However, students are not required to use them; all students are introduced to the computer and taught to sign on. When a topic in class is covered by a computer program, the professor reminds students about the availability of computer programs for drill purposes.

The chemistry faculty member is the only faculty member at Pine involved in the CAUSE project. He attributed that to the lack of faculty compensation or release time provided by CAUSE funds. He notes that programming computer materials is time-consuming but there are other faculty at Pine heavily involved in computing. The distance between Pine and CCHEI, according to him, does not promote good communication about the project.

Locust College. Next we visited Locust College which has about 1800 students, many of them in international studies. The college is supported by the Dutch Reformed Church and was begun in 1853. Locust College acquireda PDP 11/70 three or four years ago and it now has about

30 terminals. They have dropped their tie-in to the University system.

We were scheduled to meet two faculty members at Locust who have CAUSE module development projects. A faculty member in math was unable to meet with us, but we did have an opportunity to meet with a faculty member in biology. The biologist had applications approved for revision and documentation of five modules in biology. He was not able to find students interested in and skilled enough to do the work. He described the problem as one of a lack of "computer jocks" at the college.

He was able to get two students to start work on the modules but neither had time to complete the work. He said that unless a student is able to take an independent study that his/her schedule is too busy to take on extra work. He did work closely with the student programmers, laying out the work, describing the guidelines, and specifying what needed to be done. The modules were not completed due to time constraints.

The biology professor told us that the modules never will be completed because he has found programs available from CONDUIT to replace all the modules he was developing except for one on the chemistry of genetics. If he has the time during the summer he will complete that module himself.

The University. Our last stop on our last trip was the University. There we met with a faculty member in math. She explained her teaching interests and responsibilities to us. She is very interested in helping students to get a good foundation in the basic concepts in math. To that end she has gotten the math department to create a tutoring center in math. Remedial instruction is available on-line and from tutors in small groups or one-to-one. Prior to starting the tutoring center she was responsible for running the computer lab where we found her and her student programmer working on a CAUSE module.

She told us that her interest in teaching basic math concepts and in computing explain the topic of her CAUSE module -- introducing the concept of a variable. The module asks the student to identify and manipulate the content of boxes shown on the CRT. These exercises introduce and illustrate in a concrete manner what a variable is.

The student programmer and the math faculty member have been working together on the module off and on over the period of a year. Both have very busy schedules and have had some difficulty squeezing in one more activity - the CAUSE module. She said that without the CAUSE funds to hire a programmer she could not have prepared her module. She said that she was much too busy to undertake the programming of such a module herself. Although there are many computer resources--in terms of hardware, software, and expertise--at the University, funds do not exist for a faculty member to hire someone to program instructional materials for a course. She said CAUSE permitted her to create the module she wanted.

In addition to the mathematician's module, three other modules have been completed by University faculty members. Two have been completed in political science for the Laboratory for Political Research. The third one was completed by a chemistry faculty member. We did not take the opportunity to interview these faculty members.

The math professor at the University was the last faculty member participating in the CAUSE project that we had an opportunity to interview personally. Several other faculty members have since initiated projects. A few of these people have been interviewed by the cost analyst.

Return to CCHEI central office. During our visits to CCHEI we interviewed CCHEI staff twice: once before we visited any member institutions and again after all our visits were completed. The focus of our first interview was to understand how the project was actually implemented, to find out which faculty members were involved in the project, and to gather information from the CAUSE project director and assistant project director about their views of the strengths and weaknesses of the CAUSE project. The second visit focused on an update of project activities, a discussion of changes in the project, and an assessment from the project director of project impact within and outside CCHEI.

Several interesting issues emerged from our discussions with the project staff members. These are themes which seem to run through many of the activities and outcomes on this CAUSE project. The first is the problem of defining the scope of work in one module. Application for CAUSE funds to pay programmers is based on breaking the instruction into modules. The rationale for payment by module is to prevent overpaying a student programmer who is learning as s/he goes. In other words, all programmers will be reimbursed for a completed module at the same rate no matter how fast or slow they are in doing the programming. Several unintended outcomes of this approach have taken place. First, faculty members and CCHEI staff have had difficulty anticipating how much content should be covered in one module. Many of the modules which have already been completed contain more than one computer program which equals more than one "unit of teaching". A few faculty members accurately estimated the amount to be covered by a module. At least one faculty member recognized part way through the development process that the module involved creating more than one program and arranged for extra payments for the student. In interviews a number of faculty members commented on the fact that too much programming went into one module. However, these faculty members did not follow up their observations with any attempt to break their modules into more modules once they were under development.

The fact that most of the modules programmed with CAUSE funds contain more than one program has caused another unintended outcome on this project. The original proposal called for 120 modules to be completed. To date, in the final year of the project, approximately 60 modules have been created. In comparing numbers only, one might conclude that the project did not do what it promised. Comments from the project director and most of the faculty members make it apparent that the goal has been met in the following sense: If the completed modules were examined and broken into modules of equal content coverage in terms of number of exercises or concepts, then more than 120 modules are already finished.

Another theme of this CAUSE project is the rapidly changing computer technology. Of the ten CCHEI institutions which have developed modules for the CAUSE project, seven of these have small computers on campus that fulfill almost all the academic computing needs of that institution. These colleges rely very little on their CCHEI linkups for academic computing but may do their administrative data processing on the University system. The other three colleges rely more heavily on the CCHEI hookup but have at least one or two microprocessors on campus.

Between the time the CAUSE proposal was written and now, hardware resources have been upgraded or changed on many of these campuses. The original budget for the CAUSE project contains $48,000 for computer time. A large percentage of that money has not been used because where and how the CCHEI colleges do their academic computing has shifted. The advances in computer technology have made a wider range of hardware available to the colleges in a short period of time. These changes in academic computing resources may have been the source of some of the transportability problems described by so many faculty members. At the time the proposal was written modules might have been developed by faculty members at consortium institutions on the University computer via CCHEI hookup.

A third theme of this CAUSE project may be related to the first theme of estimating module size and that is that this project is a consortium project. A very small percentage of CAUSE projects operate across a set of colleges and universities. The kind of project seen in CCHEI has special situations with which to deal. The faculty members and project staff are separated by time and space which greatly increases difficulties in notifying faculty members about project activities and in monitoring their progress on their tasks. In addition, the institutions differ in mission and goals, in the type of students served, in academic requirements, in policies affecting faculty, and in academic year calendars. For example, if all the CAUSE CCHEI faculty members were part of one college on one campus the problem of delineating the scope of a module might have been solved over time through meetings and in personal conversations. However, these opportunities for formal and informal interactions just cannot be replicated in a consortium. The faculty members who have participated in the CAUSE project vary in terms of how well informed they are about the CAUSE project and other CCHEI activities. The central office staff works very hard to keep everyone up to date and to keep track of all the work being done on the project. In addition, the CAUSE project director is responsible for communications with other CAUSE project directors and interested others at national meetings and via correspondence which consumes a sizeable percentage of project time.

The fourth issue we observed on this project is faculty involvement. In order for the project to be successful in creating new computer modules and in improving instruction, faculty members have to participate. The modules are intended to be used in undergraduate science courses. The instructors of those courses must recognize a need to upgrade instruction and decide to apply for CAUSE funds. It is then their responsibility to design the module and to monitor the student programmer. Almost all the faculty members we interviewed commented on how much time module development required. Most of them chose to participate in the project because they wanted to take advantage of having a student programmer to help them. All the faculty members are very interested in instructional computing. Despite their motivation to participate in the project, the faculty members still found themselves overburdened by the development task. The several faculty members we interviewed who are participating in the project cited lack of time or over-committed schedules. A number of people suggested that the CAUSE project should have been designed so faculty members could be paid for their time in the summer or given release time.

During the second year of the project, the project director sought to remedy this problem. She applied for and received permission from the CAUSE program to change the budget. About the time of our last visit she announced availability of summer funding to pay faculty members to develop modules. She told us that a few faculty members who had already finished modules inquired about being paid retroactively. We did not have an opportunity to observe the effects of this change in the project but assume that it will have an important impact.

Where Will CCHEI Go After CAUSE?

The CCHEI has been in existence for some time. The software library has been expanded considerably with CAUSE funds. Faculty members at consortium institutions have made limited use of the CAUSE modules. Use is likely to increase as they become familiar with the content of the modules. Requests for access to CAUSE modules have also come from faculty members outside CCHEI, from other nearby institutions, and from across the country. CCHEI is an established part of the computing center as a user service of the University. Continuation of its staff and services are assured by the University. What will not be available and what has been provided uniquely by CAUSE is funds for designing and programming small packages of new instructional computer materials. Faculty members will have to rely on their own institutions for support. Of course, now that the CCHEI library has increased they may find some modules which fit their needs without having to develop them from scratch.

Project Costs

This section of the report presents an analysis of the various resources committed to this CAUSE project. The overall distribution of the project's financial resources by project activity is presented first. This is followed by a detailed examination of the resource requirements of a sample of individual software development efforts. A concluding section discusses some of the issues raised here for CAUSE funding of similar projects in the future.

Procedure

The cost analyst, Richard Lent, visited the CAUSE project director at CCHEI central offices during the spring of the project's third year of funding. While this visit occurred near the end of the project, many activities remained to be completed and only an interim picture of project costs was obtained.

Before visiting CCHEI, the cost analyst discussed this project with one member of the case study team and read a draft version of the case study report. From this information it was concluded that the major focus of the cost analysis should be the resources consumed by individual faculty in conducting software development projects. Given the geographically dispersed nature of the consortium colleges, it was decided to interview a sample of faculty by telephone rather than in person. The project director suggested nine development projects as the subjects for this cost analysis. All except the two most recent projects were chosen partly on the basis that the case study team had already met with the faculty authors/developers involved and, hence, information on the nature of these projects was available. These nine projects involved the development of 26 modules and were conducted by nine different faculty at seven colleges.

Over the next several weeks, a series of half-hour telephone interviews were held with the faculty on the selected projects. Faculty were asked to describe the time spent by themselves, their student programmer and anyone else in developing the materials. Some attempt was also made to gather information on the costs of computer time, secretarial support and other resources consumed by the project at the local college. Generally, however, these miscellaneous resources were small and very difficult to estimate and were subsequently dropped from consideration. The project director provided all the information on CCHEI central office costs of each project and the amount of CAUSE support for the faculty and student programmer's efforts. The monetary value of a faculty member's time was estimated on the basis of his/her current salary.

Generally, the information obtained from the faculty interviews can be considered to be only roughly representative of the true costs of a project. A project's major cost item was, typically, a faculty member's time and the amount of his time had to be estimated by recalling activities scattered over a period as much as a year or two in the past. It is obviously difficult to recall the amount of time spent on specific activities which were part of an overall workday. Whatever error has resulted from these time estimates, however, can be assumed to have produced a more conservative estimate of a project's total cost than was actually the case. Estimates are conservative because a project was considered to begin with the preparation of a proposal to receive funding from CCHEI. Preparation of this proposal, however, did not represent the true beginning of the development effort as most faculty had previously spent considerable time in preparing earlier versions of the materials. Therefore, only considering a project's costs from proposal preparation onward was bound to underestimate the true amount of the total resources committed to the effort over time.

Results

Overall distribution of resources. From the information contained in the project's CAUSE proposal, (Budget Summary and Detailed Budget forms) the intended allocation of funds by items of expenditure is as shown in Table 16. At the time of the cost analysis visit during the project's third year, project funds had been distributed as planned with two exceptions. First, most of the workshops (line 21) had not been held as planned due to reconsideration of their role in the project. Current plans called for a lesser number of better funded workshops to be held as projects are completed for materials dissemination purposes. Second, the amount of resources required for project computer time (line 24) had been overestimated and, on approval from CAUSE, $16,000 had been transferred from this item to line 13. The additional money for "assistants" will be used to cover some of the faculty members' costs in participating in the project.

While this kind of rough accounting of the project's expenditures provides a simple picture of the available resources, it does little to illustrate the relationship between the project's resources and its outcomes. Such a relationship can be considered, however, if the budget is reorganized by areas of functional activity. The projects' original objectives (as stated in the proposal) are too broad to define these

Table 16

Original Budget
Computer Consortium for Higher Education Institutions' CAUSE Project

	Requested from NSF
SALARIES AND WAGES	
11. Project Director (25% for 3 years)	$ 15,000
12. Professional Staff-CCHEI Programmer (100% for 3 years)	45,000
13. Assistants-Student Programmers ($200/module)	24,000
15. Secretarial and Clerical	7,500
16. TOTAL: SALARIES & WAGES	91,500
17. Staff Benefits	11,475
18. TOTAL: SALARIES, WAGES & BENEFITS	102,975
OTHER DIRECT COSTS	
20. Staff Travel (CCHEI "circuit riding")	2,160
21. Field Trips-Workshop (4/year)	6,000
22. Reference Materials-(authoring, documenting & programming guides)	1,800
23. Office Supplies	1,800
24. Computer Time (CCHEI storage, editing, compilation testing at $400/module)	48,000
28. TOTAL DIRECT COST	162,735
29. INDIRECT COSTS	38,430
30. TOTAL COST OF PROJECT	201,165
31. TOTAL CONTRIBUTED BY INSTITUTION	68,935
32. TOTAL AWARD FROM NSF	132,200

functional areas directly, but considering the activities necessary to achieve these objectives and reviewing the nature of the projects' operations readily suggests these areas of functional activity:

I. Support for faculty efforts to develop high quality, transportable computer software;

II. Evaluation, installation and maintenance of these materials on the CCHEI system; and

III. Dissemination of information on the available materials to further their use by consortium faculty.

In addition to these three areas, a fourth functional activity involves general administration of the project as a whole. For purposes of the cost analysis, however, project administration is not considered as a separate functional activity since it is difficult to distinguish its activities from those of the other three areas. Project administration is assumed to support the three functional activities above in direct proportion to the amount of resources devoted to each.

Table 17 reorganizes the project's budget by functional activities. It can be seen that the first activity (I), faculty software development efforts, originally accounted for 21% of the budget but this has increased to 33% of the budget as a result of the recent transfer of $16,000 as mentioned above. The $16,000 was transferred out of a budget item supporting CCHEI responsibilities under the second area of functional activity accounting for its drop from 74% to 62% of the budget. The final area of activity (III), dissemination of information has remained at 5% and most of its funds (for workshops) have yet to be expended.

Resource requirements of software development. The cornerstone of this project is the faculty software development activity as it is only through this activity that the project's objectives can be achieved.

Table 17

Project Budget by Functional Activity

Areas of Functional Activity	Original Budget[a] Allocation	Original Budget[a] As % of Total[b] Direct Costs	Revised Budget[a] Allocation	Revised Budget[a] As % of Total[b] Direct Costs
I Support for faculty, software, development efforts (from budget lines 13, 22)	$ 31,270	21%	$ 50,662	33%
II Evaluation, installation & maintenance of materials on CCHEI system (from budget lines 12, 24)	$112,718	74%	$ 93,325	62%
III Dissemination of information on available materials (from line 21)	$ 7,272	5%	$ 7,272	5%

[a] It is assumed that the project director's salary (line 11) as well as secretarial, office supplies, and staff travel expenses (lines 15, 20, 23) are primarily devoted to general project administration and those funds have been allocated in proportion to the resources devoted to the three main functional activities.

[b] Staff benefits excluded.

From a cost analysis viewpoint, then, it is important to look at the distribution of project resources as they are used to support individual faculty materials development efforts. Some indication that this is an important area of resource allocation decisions is apparent in the project's recent reallocation of resources from CCHEI's area of functional activity (II) to the support of faculty software development (I) as noted in Table 17. An individual software development effort can be assumed to begin with a faculty member's proposal for CCHEI funding. The proposal is then reviewed by other faculty contacted by the CCHEI prior to the decision to fund the proposal. Once approval has been received, the faculty member obtains the services of a student programmer and begins the process of module development. Finally, the completed module is submitted to the CCHEI where it is reviewed and installed on the computer system. Some of the activities are expressly covered by the CAUSE project budget and some are not. Module development activities fall under functional area I and most of the rest of the activities under II, but it is also apparent that some activities are completed through donated services.

Table 18 summarizes the resources actually required to complete nine individual materials development efforts. By comparing the last two lines of the table, Total Cost and Total Support by CAUSE, it is possible to estimate the degree to which development efforts required contributions of time and services beyond the support provided by the CAUSE project. What is not apparent from this table is which development costs are covered by CAUSE and which are donated.

Table 19 presents the average costs for developing one module and indicates which of the incurred expenses are actually covered by CAUSE

Table 18

Cost of Nine Software Development Efforts

	Development Efforts (College & Subject)								
	Oak College Anthropology	Oak College Statistics	Oak College Psychology	Ash College Chemistry	Pine College Chemistry	Aspen College Physics	Locust Col. Biology	Catalpa Col. Geography	Chestnut Col. Mathematics
Number of Modules	8	5	1	1	1	1	5	1	1 of 3
Activities:									
Proposal Development									
-Faculty Author's Time	$ 100	$ 130	$ 20	$ 24	$ 22	$ 80	$240	$ 48	$ 210
- CCHEI Staff Time	9	18	9	27	9	9	216	9	9
-Reviewer's Time	28	28	84	10	14	21	70	14	42
Module(s) Development									
-Faculty Author's Time	600[a]	1200	300	264	154	510	200	1464[a]	1470
-Student Programmer Time	1200	1000	250	140	28	124		868[a]	410
Review and Installation							Project incomplete, no student available		
-CCHEI Staff Time	3082	1097	72	113	1047	27		18[a]	36[a]
-Materials Reviewer's Time	112[a]	252	42	60	70	21		14[a]	56
-Computer/ other CCHEI Costs	596	25	36	10	10	10		10[a]	10
Total Cost	$5727	$3750	$813	$648	$1354	$802		$2445[a]	$2243[a]
Total Support by CAUSE	$5287	$2140	$286	$350	$1266	$246		$1328[a]	$1555[a]

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[a] Predicted in advance of project completion.

Table 19

Average Costs for Completing One Module Under Original Budget Guidelines[a]

Activity	Cost As: Incurred	Cost As: Supported
Proposal Development & Review[b]		
Faculty Author's Time[c]	$ 63	
CCHEI Staff Time	14	14
Proposal Reviewer's Time[d]	31	
Module Development		
Faculty Author's Time[c]	257	
Student Programmer Time[e]	157	200
Review and Installation		
CCHEI Staff Time[f]	457	457
Materials Reviewer's Time	43	
Computer/Other CCHEI Costs[g]	25	25
TOTALS[h]	$1047	$696

Notes

[a] Based on a sample of six completed projects funded under original budget guidelines which did not cover any direct compensation to faculty. The most expensive of these projects cost $1354 per module, and the least expensive, $648 per module. The majority of the projects cost between $800 and $900 per module.

[b] This can be considered a fixed cost of a project that does not recur with each succeeding module proposed as part of original project.

[c] Based on faculty estimates of their time and reported salaries.

[d] Senior faculty from consortium institution who have volunteered to act as reviewers. Estimates of their time and salaries provided by Project Director.

[e] Based on time estimates of faculty author, and a typical student wage of $2.50 an hour.

[f] Includes time for programming on CCHEI system (the major expenditure here) as estimated by Project Director.

[g] Based on a general estimate of computer connect time at $10/hour. No attempt has been made to estimate computer costs at faculty author's institution.

[h] Some economy of scale is possible for module development and review/installation for those projects involving more than one module. On the evidence of this sample of materials development efforts, however, cost-per-module seems unlikely to drop below $800.

funds. Thus, the "average module" is seen to cost $1047 to develop and install as per project guidelines and $696 of that total is actually supported by the CAUSE project budget (including both NSF funds and the University's contribution).

What Table 19 shows in particular, however, is that the gap between the total cost incurred and the budgeted support for materials development is largely made up by the donated services of the faculty author. For this average development effort, the faculty member's donation amounts to $320 ($63 + $257) of his/her time. It is specifically this situation that is now being addressed through the reallocation of project funds noted in Table 17. The switch of $16,000 to the first area of functional activity provides funds to compensate faculty for some of the time they formerly donated. The impact of these new guidelines are not shown in the average module development costs of Table 19; however, the two most recent development efforts in Table 18 (Catalpa's geography and Chestnut's mathematics modules) include from $500 to $1500 in support of the faculty member's time.

Discussion

While this CAUSE project has been successful in achieving its objectives, it has had some resource allocation difficulties. These difficulties have had more to do with determining the most effective allocation of resources across project activities than with the total amount of resources available. Allocation issues are apparent both at the level of individual software development efforts and for the project as a whole.

At the level of software development efforts, Table 19 suggests that faculty contributions to module development have been extensive, perhaps more extensive than originally anticipated. The CAUSE project was conceived as a means of "improving the quality of instructional computing available to each consortium member." This was to be done through improving existing computer programs and documentation so as to make these materials easier to use and more readily transportable across consortium institutions. It was assumed that these improvements could be accomplished by CCHEI staff and student programmers working under the general guidance of faculty. This assumption was the basis for the original allocation of resources which emphasized supporting student programmers and CCHEI staff.

As the CAUSE project began operations, however, the role of faculty turned out to be more than that of content expert and general overseer. Faculty had to take active responsibility for a large if not major portion of software development activities. Interviews with faculty highlighted the fact that many of them found revising materials to ensure their transportability to be as difficult a task as the original creation of the materials had been. Student programmers were of some help, but sometimes required considerable tutoring before they could be of any real service. Furthermore, the faculty member could invest considerable time in a development effort only to find that no suitable student programmer was available (as in the Locust College project listed in Table 18). While little can be done about lost faculty time due to this last (and infrequent) circumstance, the recent reorganization of the budget allows for greater recognition and compensation for the significant role played by faculty in module development.

A second level of resource allocation issues outlined by this cost analysis relates to the optimum utilization of project resources to insure maximum long-term benefit to consortium science education programs. Of concern here is the amount of attention devoted to the third functional area of project activities, dissemination. While the project will result in improvements to the body of instructional computing materials available to consortium institutions on the CCHEI system, without adequate efforts to inform faculty of the nature and availability of these materials the maximum appropriate use of (and thus benefits derived from) these materials is unlikely to result. As shown in Table17, only 5% of the project's budget has been allocated to dissemination activities, specifically, faculty workshops. (Not included in this budget is the cost of the CCHEI newsletter which also plays a role in disseminating information on available materials.) The project director has already given careful consideration to the effectiveness of the workshop dissemination strategy as originally conceived and budgeted. Plans for a new and more adequately funded form of workshop are underway.

Overall, the cost analysis of this project has suggested that initial budgetary decisions had not allocated project resources in a manner which facilitated the optimum attainment of project objectives. These difficulties have been recognized, however, and subsequent reallocation of resources has increased the likelihood that the project will attain its full potential.

FORESTVIEW COLLEGE:
AID TO ENVIRONMENTAL SCIENCE AND AN ENDANGERED COLLEGE

Site Visitors: Jacquelyn Beyer
Richard Lent

Primary Author: Richard Lent

Preface

Forestview College is renowned for its long history as a leading innovator in American higher education. In recent years, however, a series of financial setbacks, declining enrollments and other difficulties have seriously threatened the college's ability to survive. These problems came to a head recently when a cash-flow crisis almost closed the school for good. It is against this background of the college's traditional spirit and current difficulties that the conduct and outcomes of this CAUSE project must be understood.

At the time of this report, the CAUSE project was near the end of its second of three years. The project was well on the way to achieving its initial objectives, but these objectives had become only one aspect of the impact of CAUSE funding. Creative project management and grantsmanship efforts coupled with the project's timing relative to critical events at Forestview have produced a project which is having far more ramifications for the future of the college's science education programs than would be normally thought possible. Forestview's project illustrates both some unexpected benefits and problems that CAUSE projects may hold for the science faculty of a small college. More generally, this project shows how the cost-effectiveness of initial plans can sometimes be improved.

The real names of all the people, places, and the college have been changed to fictional names to protect the privacy of the participants in this case study. The articles from the alumni newsletter have been retyped in order to change the names. The substance of the articles is the same as it actually appeared in print. The Kresge Foundation and the Fisher Scientific Company have been identified by their real names.

Introduction

CAUSE funding at Forestview College supports the efforts of a group of natural science faculty to develop the necessary courses and to obtain the supporting equipment and facilities for an improved environmental science program. The three-year project began in 1978 with a grant of $241,392 from NSF matched by $126,696 of Forestview's funds. Aside from supporting course development efforts, the project's largest single expenditures are for computer and laboratory equipment and laboratory renovations.

Overview of report. The story of Forestview's CAUSE project can best be understood within the sequence of events which surround it. The report begins with a description of the institution and the series of efforts which led up to the present project. The next section of the report describes the events and activities involved in implementing the project's plans (focusing on the first two years of the three-year effort). Concluding sections consider the probable outcomes and costs of the completed project. As a preface to the body of the report, the following section reviews the means employed by the case study team to develop our understanding of the project.

Case study method. After reading the proposal, the case study team's initial impression of the project was that of a kind of panacea designed to address almost every dimension of science education improvement from equipment purchases to facilities renovations to course development. We wondered whether, in practice, the project would have remained this broad or would have come to focus more narrowly on certain of its objectives.

The first visit to Forestview occurred near the end of the project's first year. During that visit, two characteristics of the project became apparent almost immediately: the project was even more extensive in its activities and potential impact than the proposal suggested, and the process of project implementation was going more slowly than expected. As a result of these trends, we became concerned with obtaining as broad as possible a view of the project within the context of the institution and with spacing the visits as far apart as possible to allow time for various plans to mature.

Over the course of a year, we interviewed 35 faculty, students, and administrators from all areas of the college. Many of the project-related personnel were interviewed more than once (see Table 20). Observations of various class sessions were conducted as well as tours of the science facilities before, during, and after renovations. Every effort was made to gather as much documentary evidence as possible on the history of the project and certain critical events in the college's recent history.

By the end of our visits we were fairly confident that we had acquired an adequate understanding of the project up to that point in the project's life. Almost all of our interactions with faculty and students were frank and open. Project personnel were very helpful with all aspects of the inquiry. Threats to the validity of our findings, however, are possible in that (1), by focusing on project activites we may have a biased view of the project in the context of the institution, or (2), by only seeing the project in its first and second years we have mis-estimated the eventual outcomes of the project. An effort was made to counter the first weakness by interviewing as many people outside of the CAUSE project

Table 20

People Interviewed by Visit and Relationship to Project

Name	Position	Interviewed During:		
		4/79	11/79	4/80
CAUSE Project Members				
P. Thompson	Project Director, Director of Science Institute, and Assoc. Prof. of Earth Science	X	X	X
R. Brown	Professor of Biology			X
R. Caldwell	Assoc. Prof. of Computer Science	X	On leave	
J. Hopewell	Assoc. Professor of Biology	X	On leave	
C. Tyler	Assoc. Professor of Physics	X	X	X
D. Upton	Ass't Professor of Chemistry	X	Left college	
D. Young[a]	Professor of Chemistry		X	X
W. Wallace[b]	Professor of Mathematics			X
T. Andrews	Technical Assistant	X	X	X
R. Graham	Prof. of Education, Consultant on Evaluation	X		
Student Assistants (3)			X	X
Non-CAUSE Environmental Studies Faculty				
R. Ferrante	Assoc. Professor of Geography	X	Left college	
D. Moore	Professor of Engineering	X	Deceased	
Other Science Faculty/Staff				
R. Bell	Administrative Assistant	X		
E. Smith	Professor of Biology			X
V. Ayers	Professor of Anthropology		X	
Science and Environmental Studies Students (total of 10)		X	X	X
Non-Science Faculty				
J. Russel	Professor of Music		X	
C. Perlman[c]	Professor of Economics			X
P. Roseman	Professor of Education			X
Administrators				
J. Hempstead	Development Office	X		
D. Jones	Cooperative Education	X		
T. Williams[d]	Associate Academic Dean	X		X
H. Goodwin	Academic Dean			X
R. Rowe	Director, Outdoor Ed. Center	X		
D. Mathews	Cooperative Education		X	X
S. Thayer	Assistant Registrar		X	

[a] Appointed to replace Upton

[b] Appointed to replace Caldwell (temporarily if not permanently)

[c] Recently appointed to fill T. William's position

[d] Returning to position as Professor of Mathematics

and the sciences as possible. The second weakness is more difficult to counter as the press of local events was modifying the project's pace and direction almost continually, giving us a somewhat different impression on each visit. Therefore, we suspect that if we were to return again next year, we would once again revise our understanding of the project's overall outcomes. While nothing can be done to counter this weakness, some factors can be identified which are likely to have an impact upon the success of the project's final year. Those factors are outlined in a separate section under Project Implementation.

Background on Forestview and the Project

One of this country's most famous educators founded Forestview College in 1852, describing it as "this one liberal institution in the midst of a world of intolerance". He was the college's first president and helped to establish the tradition of a quality liberal arts education that emphasizes a philosophy of questioning the way things are and actively working to improve them. "Be ashamed to die," he urged, "until you have won some victory for humanity."

This philosophy remains one distinguishing characteristic of a Forestview education. Another important characteristic was introduced by a later president who created Forestview's work-study (co-op) program under which every student alternates periods of on-campus study with off-campus work. The work experience is viewed as a regular part of the curriculum and the college provides considerable assistance to students in finding "co-op" jobs that match their academic interests and career aspirations.

Through the 1960's and early 1970's, Forestview was led by another well-known, enthusiastic, but controversial president. He expanded the Forestview concept from that of a small college in rural mid-America to that of the first national university with centers around the country devoted to particular fields of study or addressing the needs of special populations (e.g., Eskimos, Mexican-Americans or inner-city blacks). Meanwhile, things were blossoming on the home campus as well. Forestview's educational philosophy matched the spirit of the times, the home campus enrollments reached 2,000 students and a number of additions were made to the college's programs and physical plant.

Forestview's period of good fortune was not to last for long. By the early 1970s, various external and internal pressures were threatening the future of the institution. Externally, Forestview had gained a reputation as a center of radical politics and began receiving unfavorable attention in the media. Internally, the creation of the network of university centers along with expansions at the home campus had stretched Forestview's resources and administrative capabilities to the limit. A series of increasingly bitter, sometimes violent and always publicized disputes began between the college president and the local students and faculty. This president was finally pressured to resign in 1975, but not until several years of strife had inflicted serious physical and psychic damage to the fabric of the institution.

Today, a new president heads a much smaller university and college. The home campus enrollments have dropped below 1,000 students and may hit a low of 600 students by next fall. After several years of worsening financial conditions, the university underwent a cash crisis in the spring of 1979 that nearly closed the school for good (and did cause faculty and staff to complete the semester without pay). The college itself, if not the whole university, was on the verge of extinction.

One year later, there was reason to believe those who argued that Forestview had "bottomed out" and was on its way to recovery. The case for this argument rests on the efforts and attitude of Forestview's faculty, staff, and alumni, all of whom are extremely committed to the survival of the institution. Some indication of the strength of support on the home campus is evident in the fact that the majority of the faculty have stayed with the college through a very long and trying period (even when they could no longer count on being paid). Forestview's alumni have also provided fast and effective financial support. Aid to the college has been so effective that Forestview has regained some fiscal stability (including its credit rating). In April 1980, Forestview's president was able to tell the faculty that he was "cautiously comfortable in reporting that the university has in fact broken through and turned around, dramatically broken from its past fiscal behavior, and turned to new disciplines that are working".

Science Education at Forestview

The college has a long and extensive involvement in science. In the 1920's, its president devoted considerable attention to strengthening Forestview's resources for scientific research and teaching. A Research Institute was founded on campus along with several scientific equipment businesses. Several other nationally-prominent commercial research laboratories were also enticed to relocate near campus. Finally, in 1930, a General Motors chief engineer gave Forestview the Science Building which is still in use today.

Forestview stresses an interdisciplinary (as well as disciplinary) approach to science education. In 1968, the traditional departmental structure was abolished to create the Science Institute. This is administered by an elected Science Institute Director and a council of four faculty and four student science majors. The abolition of departments made it easier to share equipment, space, secretarial and technical assistance. When the CAUSE project began, the Science Institute encompassed 19 faculty and a curriculum which offered specializations in biology, chemistry, computer science, earth science, engineering, environmental studies, mathematics, physics, and pre-medical studies. From 15 to 30 students were graduating in environmental studies each year.

Over time, Forestview has consistently ranked among the top liberal arts institutions in the production of scientists (Hardy, 1974). Its graduates have regularly achieved a high rate of acceptance (60%-70%) to medical schools. In the last several years, four different NSF grants have been awarded to Forestview students under the Student Originated Studies program.

Need for CAUSE project. While Forestview has done a good job of establishing and maintaining the quality of its science programs, it has been obvious for a number of years that a new infusion of resources was needed if the quality of these programs was to be upheld in the future. Some of the difficulties facing the Science Institute date from 1959 when the top floor of the Science Building was involved in a serious fire and the insurance money ran out before all of the damages could be repaired. The building's first three floors, however, remained pretty much as they were when first built fifty years earlier. Various equipment purchases and minor renovations had been made over the years, but gradually the basic laboratory facilities and equipment wore out. In the opinion of its faculty and students, Forestview was falling behind national norms for the quality of science education facilities.

In spite of its meager resources, the faculty was able to maintain Forestview's standards for the preparation of its science graduates. This was accomplished through Forestview's emphasis on an approach to science education which focused on student acquisition of scientific reasoning and understanding over and above the technical skills required to use scientific equipment and procedures. This did not mean, however, that equipment and procedure skills were ignored: the work-study program helped the college to overcome its facilities and equipment deficiencies by providing students with work experiences in some of the most modern and best equipped professional laboratories. Finally, students transferring to Forestview from other institutions noted that while Forestview had less equipment and fewer facilities than their other institutions, what equipment and facilities the college did have were much more accessible to students.

Overall, Forestview was doing a very good job with what resources it had but it was running out of ways to make up for its deficiencies. Major improvements to its facilities and equipment were needed if the college was to maintain any serious science programs. The resources to make these improvements, however, were not available.

History of Pre-Project Efforts to Obtain Funding

Prior to the awarding of the present contract, Forestview's science faculty had made a number of attempts to obtain funds for facilities renovations. In 1974, a retired member of the Chemistry faculty obtained a $10,000 grant from a local foundation to fund a planning study and cost analysis of the Science Building's renovation requirements. A year later, the Science Institute director of the time submitted the first proposal to NSF for funds to support building renovations. In 1976, he tried another proposal to NSF, this time including a request for funds to cover some academic program development in addition to the renovation requirements. The following year under the Science Institute's new director, Paul Thompson, an application was made to the Kresge Foundation for a building renovation grant. This appeal, too, was turned down, but shortly thereafter the CAUSE proposal was prepared that ultimately resulted in the present project.

Preparing the CAUSE proposal. Three lines of thought were combined in preparing the final CAUSE proposal. First, the need (and history of unsuccessful applications) for building renovations funds was well-known to Thompson. Second, a special task force headed by one of the science faculty had just completed a report to the college president recommending an increased emphasis on environmental studies. (There was even some discussion that environmental studies might provide the first national curriculum for the university by linking related activities in California and New Hampshire centers to the environmental science programs on the home campus). Third and finally, Thompson made an open request to the science faculty to contribute their ideas as to projects they wanted to undertake that they felt CAUSE would be likely to support.

Thompson, the intended project director, wrote a first draft of the proposal incorporating those important needs and ideas that seemed to fit together. This draft was reviewed by a member of the college who had some professional grant writing experience. He suggested various modifications to the proposal to make it more focused on improvements to an educational program and less on simply acquiring a set of instructional "tools" and equipment.

By this point, the thrust of the proposal had narrowed to emphasize the quantification of environmental science. New courses were to be developed based upon the data gathering and analysis techniques and equipment appropriate to a more quantitative approach to environmental subjects than had heretofore been possible at Forestview. If funded, the CAUSE project would provide release time to faculty to develop these courses, but more importantly would provide the funds to purchase the necessary scientific and audiovisual equipment[1], and computer capabilities in support of the intended goals and activities of these courses. In this proposal, the concern for renovations to science building facilities was reduced to address only the laboratory space most in need of repair and directly related to environmental science courses (environmental chemistry and ecology/aquatic environmental laboratories).

Each of the six faculty to be involved in the CAUSE project prepared a budget for their equipment purchases based upon information available to them at the time. Plans and budget for the laboratory renovation were derived from earlier grant applications (from the original study funded by the local foundation).

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[1] The role of audiovisual equipment in teaching science subjects had been established through one faculty member's activities under a recent LOCI grant. That grant did not cover equipment purchases, however, so to some extent this project was beginning from where that one left off.

The proposal was duly submitted. Based upon their grant-getting history, however, some of the faculty had little expectation that they would be funded. In general, this proposal was seen as a trial application that would be refined based on feedback from CAUSE reviewers and resubmitted the following year when, hopefully, it would be successful. The Forestview faculty were thus pleasantly surprised when they learned a few months later that they had been funded.

Kresge grant. In an action characteristic of this project as a whole, one of project director Thompson's first acts on receiving the NSF grant was to investigate ways of extending the impact of those funds and scope of the project as a whole. Working with the president, Thompson reapplied to the Kresge Foundation for Science Building renovation funds citing the NSF grant as evidence of the trust placed in the college by others. This time they were successful, receiving a $200,000 Challenge Grant towards renovation of the complete facility. The grant was subsequently matched by funds from alumni and three area firms. By 1979, the Science Building had a renovation budget of $534,000 (including the $43,000 of renovations funded under CAUSE). The history of the CAUSE and Kresge grants and other efforts to obtain funding for renovations is summarized in Figures 6-8.

Project Implementation

First Year - Springtime

The case study team first visited Forestview on April 30 and May 1, 1979. These were two beautiful spring days near the end of the project's first year. The campus was alive with students, faculty and staff bicycling

1974	Dr. James Charles, retired chemistry professor, got a $10,000 gift from a local foundation to evaluate building renovation needs.
1975	Dr. Richard Young, chemistry, worked up extensive cost details for building renovation.
1975	We applied for an NSF grant to cover the building renovation--no luck.
1976	We applied for an NSF grant that would cover some academic program and some renovation needs--no luck.
1977	We applied to Kresge Foundation for money to cover renovation--no luck.
1977	We applied for an NSF grant that would cover environmental science and renovate one lab ($43,000 for renovation, $241,000 total from NSF). It was successful.
1978	We reapplied to Kresge Foundation for money to cover renovation--were awarded $200,000 if we could raise $334,000 as a match.
1978	Local industries and individuals in the companies donated $200,175.
1979	Remainder of $534,000 raised through science building fund drive (see brochure) and unrestricted gifts.
November 19, 1979	Renovation construction began.

Figure 6: History of Grants as Posted in Science Building Hall (November, 1979)

KRESGE CHALLENGE GRANT TO RENOVATE SCIENCE HALL

[Forestview] College has received a $200,000 Challenge Grant from the Kresge Foundation toward renovation of the campus science facilities, President [William Bettmann] has announced. When the grant is matched, $400,000 toward the estimated $550,000 needed will be available for work on Science Hall....

The grant was made after a number of visits to the Kresge Foundation by President [Bettmann] and [Paul Thompson] (geology), Chairman of the Science Institute, who convinced the Foundation of [Forestview's] growing capacity for fiscal discipline, the quality of [Forestview's] leadership, and the community's determination to pull together cooperatively in behalf of the futrue of the College.

Says President [Bettmann], "Kresge's support is critical to [Forestview] at this moment in our history."

The College Science Building requires a variety of improvements ranging from new fume hoods over chemistry laboratory benches and new benches as well as new wiring, plumbing, and flooring.

The $200,000 necessary to match the Kresge Challenge Grant is built into the $16 million campaign, "[Forestview]: It Works," reported elsewhere in these pages. A group of the [Forestview] science faculty are well into special plans to realize the Kresge match by next June as one of the first achievements of the larger campaign.

Upgrading the educational effectiveness of science facilities is part of a broadscale plan to meet the physical plant requirements of the College campus well into the next century. No new construction is deemed necessary. Updating existing structures will provide adequately for projected enrollments and anticipated programs at significant savings over new construction. Moreover, increasing the efficiency of existing structures will reduce maintenance costs.

Renovations have already taken place at the campus library, two residence halls, and the [Forestview] Inn.

The College regards efficient science facilities as essential to continuing [Forestview's] strong science program and tradition as a leading liberal arts college in the preparation of professional scientists and the high percentage of its premedical students being accepted at medical schools.

Figure 7. Article from Forestview's November, 1978 alumni newsletter.

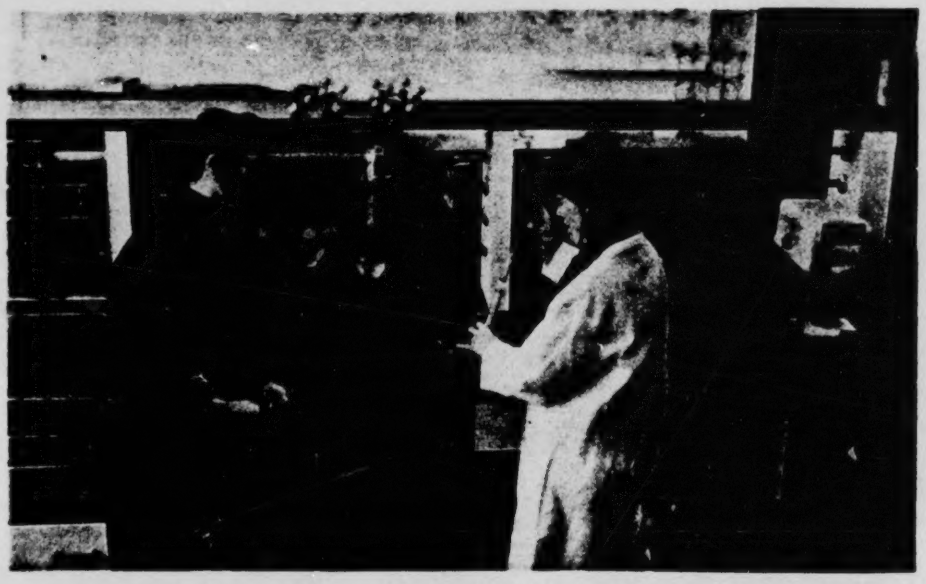
SCIENCE HALL FUND NEARS GOAL

The three leading [area] industries have given [Forestview] a big boost toward receiving the Kresge Foundation's $200,000 challenge grant for the renovation of the College's Science Hall, University President [William M. Bettmann] announced at the "[Forestview]: It Works" kickoff [on] the evening of Feb. 13.

With $40,000 allotted from a National Science Foundation grant for this purpose, $160,000 more was promised by [William Baum],'31, Chairman of the Board and Chief Executive Officer of [Thomas Baum and Co.], [George Mander], President of the [Verrot Laboratories, Inc.], and [Henry Repanier], '47, President, the [Green River Instrument Co.].

With the total building cost for Science Hall estimated at $550,000, only $150,000 needs to be raised to secure the Kresge grant and make the project possible.

Upgrading the educational effectiveness of science facilities is part of a broad plan to meet the building requirements of the College campus into the next century.



A brand-new chemistry lab bench brings a smile to the face of Chemistry Professor [Robert Young] (left) as a portent of things to come as [Forestview] gets closer to its goal of $550,000 for renovation of Science Hall on the Forestview College campus. Large gifts have already been pledged by the Kresge Foundation and three [area] industries. The new bench is the gift of Fisher Scientific Co. of Pittsburgh in exchange for one of the old benches, which it wanted for its museum. [Les Mikelsen] is the first student to demonstrate titration at the new bench after its installation.

Figure 8. Article from February, 1979 alumni newsletter.

to classes, holding discussions on the lawn, and generally enjoying the change in seasons after a long winter.

First impressions of the Science Building. Since the Science Building itself figures prominently in many of this project's activities and outcomes, it bears describing as we first encountered it on that spring morning. The Science Building is a long, massive, four-story brick structure with simple lines unadorned by any ornamentation except by an oversized concrete lintel over the main entrance in the center of the building. Long columns of steel-case windows add to the building's utilitarian appearance. The overall severity of its lines, however, are softened by the many large trees and other plantings which surround it (see Figure 9).

Inside, the Science Building had not aged gracefully. Coming in the main entrance, the first sight was of large concrete stairs progressing up or down to the various floors with the whole stairwell space boxed in by a recently added fire wall. Passing through the fire doors onto a typical floor of the building one walked into a long, high and dark corridor extending in either direction. Doors to the various classrooms and offices were recessed into the walls at intervals. The walls themselves were composed of small, square panels held in place by strips of metal. (These panels were one of the building's many innovative design features as they could be easily removed to permit access to the building's plumbing, heating, ventilation and electrical systems.) In an effort to relieve the somberness of the halls, a group of faculty and students had painted the individual panels different colors, creating a kind of checkerboard effect.

The most memorable impression made by the building, however, was created by its laboratories. One chemistry laboratory reminded one of the

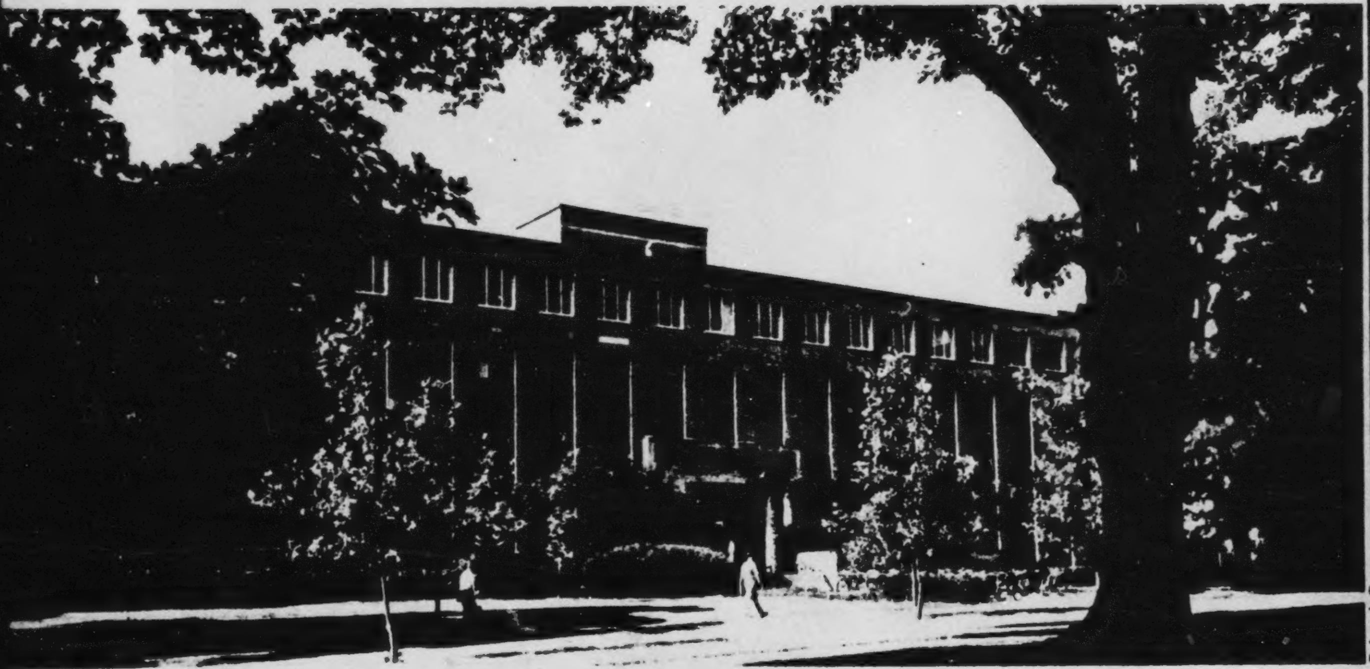
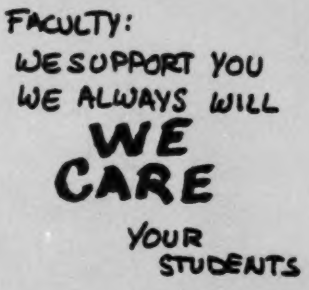


Figure 9. The Science Building at Forestview College

case study visitors of the set for the film on the life of Marie Curie. The rooms were very large with slate blackboards and large, grey asbestos board ventilation hoods along the walls. The benches had dark soapstone tops and dark wooden bases. The impression was one of a turn-of-the-century laboratory (although it is not that old).[2] But on closer inspection, whatever historical charm the laboratory might have had was marred by the wear and tear of years of use and the stains and disfigurements resulting from broken plumbing.

Faculty (and sometimes student) offices were scattered between the laboratories. Offices were generally crammed with books, papers and samples/specimens of various sorts, with the whole covered by a fine layer of academic flotsam. The hallways and doors to the offices were dotted with messages, memos and cartoons from faculty to students and vice versa. One recently posted sign in response to a local campus issue read:



FACULTY:
WE SUPPORT YOU
WE ALWAYS WILL
WE
CARE
YOUR
STUDENTS

The halls also contained numerous displays of information on current scientific subjects. In spite of the run-down status of the building, the activity and energy of its occupants was obvious.

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[2] However, one maker of scientific equipment did offer the college a new bench in return for one of these old ones which it wanted for a museum.

Overview of the visit. We found Project Director Thompson in his office. An interview schedule had been prepared but Thompson stressed his readiness to alter that schedule to fit our needs. The first several hours were spent in Thompson's office going over the history of the project to that point and the factors which had led to the creation of the proposal.

Later that morning we met with four of the CAUSE project faculty as a group. The remaining day-and-a-half was filled with meetings with other science faculty, students and administrators; building tours; classroom observation; and other planned and unplanned activities. Thompson sometimes accompanied us but frequently let us pursue our own investigations. He also generally joined us for lunch and we met him for a formal closing interview at the end of the second day. Most of the discussions were quite open and even spirited at times. Few faculty, however, were familiar with all aspects of the project.

During the closing interview, we shared our perceptions of the project with Thompson and he generally agreed with our conclusions. Furthermore, as a project director trying to coordinate the efforts of a largely autonomous group of faculty, Thompson said he felt that our visit was valuable in that it underlined the importance of increased faculty communication and cooperation on project tasks.

Activities and outcomes of the project's first year. We emphasized two areas in our interviews in this visit: first, the identification of the institutional need for this project and subsequent development of the proposal to CAUSE; and second, the project's activities and progress in its initial year. Findings in the first area have already been presented. Project activities and the outcomes of those activities for the eleven-month period from the award of the project in June, 1978 to the end of April, 1979 are listed below:

Activities:

- -Further consideration given to the plans for computer use (with implications for hardware and software requirements).
- -Reconsideration of equipment purchasing plans in the attempt to find more cost-effective expenditures.
- -Search for further funds to support additional renovations of the facilities and computer hardware purchases.
- -Tyler's fall quarter responsibilities reduced by 1/3 while he worked on developing the new solar energy course.
- -Caldwell's spring quarter responsibilities reduced 1/3 while he developed the new course on applied statistics.
- -Architect selected and plans made for building renovation to begin in the summer.

Outcomes:

- -Computer purchase delayed awaiting outcome of efforts to obtain additional funds for hardware.
- -Several new courses under development, but none offered yet.
- -Kresge grant and necessary matching funds obtained to support renovation of most of the Science Building's instructional space.
- -Project timetable slowed down to allow more time for planning and purchasing decisions.
- -Reported improvement in the morale of science faculty and students.

Conclusions. At the end of this first visit, three things seemed to stand out about Forestview's implementation of its CAUSE project: the creativity shown in the project's approach to various decisions, the ingenious use of CAUSE funds as seed money to gain support for expanded accomplishments, and the variety of impacts the project was and would be having on science education at Forestview. The best, but not only, example of creative project decision-making involved the renovation of laboratory benches. When Jim Andrews, the Science Institute's technical assistant, and Robert Young and other project faculty started investigating the laboratory benches on the market, they found that not only were the benches expensive, but they would never last as long as the college's present oak and soapstone benches had. The decision was made to investigate reconditioning the present benches. After some consultation with local stone workers, plumbers and cabinet makers, it was determined that the college could completely rebuild the original benches (including reground tops; new plumbing, wiring and sinks; and rebuilt and refinished bases) for several thousand dollars less than the cost of new benches. Thus, while the CAUSE budget was originally intended to cover the cost of three new benches, under this plan the same funds would now provide four "new" benches that could be expected to last another 50 years.

A similarly creative approach to the implementation of project plans was evidenced by several efforts to use CAUSE money as seed money with which to obtain additional support for science education improvements. As already noted, CAUSE's award of $40,000 in building renovations was used as a basis for a proposal to the Kresge Foundation which won the college a $200,000 matching grant. Later in the year, a project faculty member began to pursue the same idea in support of computer hardware purchases. A variety of efforts were made to buy used equipment, set up a matching grant, or otherwise convert approximately $30,000 in CAUSE funds into much more than $30,000 worth of hardware. Forestview faculty seemed to be adept at exacting the maximum return out of every dollar (as well as out of every bit of facilities and equipment) at their disposal.

A final remarkable characteristic of this project was the range of benefits it was appearing to have for science education at Forestview. From the perspective of the project's first year, these benefits could be categorized in terms of short, medium and long-range impacts of the project. Short-term impacts were already evident in the project's first year. These included the use of CAUSE funds as seed money for further fund raising efforts, the increased communication and collaboration among environmental science faculty, and the improvement in faculty morale. (Evidence supporting the first impact has already been noted; the last two changes were cited frequently by faculty and students throughout the Science Institute.) Among the medium-range impacts were the primary outcomes of the project: building renovations, scientific equipment and computer purchases, and new courses. Last, and most speculative, was the existence of certain long-range impacts of the project itself, or the project in combination with related efforts such as the Kresge grant. As suggested in discussions with faculty, students or administrators, these long-range impacts included: improved recruitment of students interested in the sciences (due to more impressive facilities), development of the university-wide environmental studies program, and the capability of providing environmental monitoring/assessment services to local communities. After a long decline, the arrival of the CAUSE project signaled a sudden and unexpected change in the fortunes of science education at Forestview.

It was a glorious spring afternoon when the case study team left Forestview. Most of the college's students and faculty were gathering on the lawn for an annual celebration/picnic known as the May Walk. The picture was hopeful.

Second Year - A Gray October

Ironically, on the same May afternoon that the case study team departed from a newly optimistic science faculty, the university's trustees and administrators were meeting to discuss a financial crisis that was threatening Forestview's continued existence. A few days later it was announced that the university would stay open as best it could, but college faculty and staff were asked to finish the last two months of the semester without pay. All faculty and staff were laid off for July and August and faculty were encouraged to take voluntary leaves of absence for the following year. Meanwhile, a crash fund-raising drive was initiated and Forestview's plight again received attention in the national media.

The case study team contacted Paul Thompson in June and again in September to see what was happening to the CAUSE project. All plans and activities had been suspended: after the May announcement, Thompson had contacted the CAUSE program office and all funding was stopped until the fall. While little could be expected to have occurred since their last visit, the case study team decided to return to Forestview at the end of October.

Overview of the visit. It was a cold, November-like day when the team returned to the campus. Outwardly, the college appeared to be operating normally, but there were changes. Most notably, up to a third of the faculty and staff were absent from the college. In the Science Building, everything remained pretty much as before, only there were a number of closed office doors posted with signs informing students that a particular faculty member was not on campus that term.[3]

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[3] It should be noted that very few faculty actually left the college. Most took leaves of absence, holding open the possibility of their return.

The case study team was obviously interested in seeing how the project and its associated faculty and students had weathered the May-September financial crunch in terms of both project implementation and faculty morale. They also were more concerned than ever with determining how the CAUSE project and Science Institute's activities as a whole appeared within the overall context of the institution.

Only two of the original project faculty were present in October--Charles Tyler and Paul Thompson. Richard Brown was in the area but on voluntary leave, Robert Caldwell was away on a temporary job, John Hopewell was on pre-arranged leave at Oak Ridge National Laboratory, and Donald Upton had resigned in September. Another chemistry faculty member, Robert Young, had taken charge of some of Upton's unfinished responsibilities on the project.

During this visit, the case study team interviewed the project faculty who were available as well as other members of the larger academic community. The first CAUSE-supported course to be offered was observed in operation. Finally, the cost analysis of project activities was begun.

Activities and Outcomes. The project was now well into its second year and, while some good groundwork had been laid in the first year, the CAUSE project had yet to have much outward impact on the state of science education at Forestview. Renovations, equipment and computer purchases had been held up due to the college's unstable financial condition. Course/curriculum development plans were off-schedule due to missing faculty. Meanwhile, the college's financial future was still uncertain and it was evident from their conversation that many faculty were keeping one eye on the job market. In place of anticipated improvements, the science faculty had suffered another series of setbacks. The CAUSE project and its anticipated benefits seemed very far away indeed.

Throughout this period, the project director had taken the necessary steps to keep the project alive and maintain the potential for completing its activities by the end of the third year. Building renovations would now have to be completed during the school year, but careful scheduling would enable this to happen without too much disruption to classes. The contractor/architect had completed some necessary preliminary studies on the ventilation system and was waiting to begin work. Attempts to raise additional money for, and/or donations of, computer equipment had continued. One faculty member and several students had voluntarily assumed the task of developing the environmental chemistry course--a task which had already been paid for out of project funds but left uncompleted by a departing project faculty member. Further course development activities were scheduled for later in the year. One project faculty member, temporarily on leave, was using some of his time to teach himself how to use a computer. Various equipment purchasing decisions had been completed and were ready for ordering (as soon as the college was sure it could cover its portion of the bills). In short, there was little outward activity and less hopeful talk about the project, but all the vital signs had been maintained.

Of particular importance to the project's continued viability through this period was what did not happen: no project funds were lost as a result of the cash crisis.[4] This was somewhat a matter of luck as no restricted account had been established for the project as of May's emergency. If there had been a sizable amount of CAUSE funds in the coffers at the time, that money might have gone to more pressing needs and the project left in a financial hole. While this did not happen, Thompson realized the potential for its occurrence in the future and had done his best to make sure that a restricted account was established.

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[4] The only project funds that were, in a sense, lost during this period was the money paid to a chemistry faculty member for course development who subsequently left the college. This money was paid in the summer through arrangement by the faculty member without the project director's knowledge. No materials were turned in.

Conclusions. During this visit it was clear that events at the college had overcome much of the enthusiasm and planning surrounding the project in its first year. Implementation efforts had been brought to a near standstill and the completion of the project was in question. In spite of this, however, the project director and certain faculty and staff had taken some necessary steps to maintain the project's potential. In discussions with Project Director Thompson, it even seemed possible that the project might ultimately serve a more important purpose than ever: the physical renovation of the building might provide a much needed symbol for faculty and students that things at the college could, in fact, improve. As one member of the case study team noted to Thompson, this project could be characterized in a Dickensian way as coming at the best of times and the worst of times. If only Forestview could stay financially stable and the project get underway again...

Some Outcomes - Spring of the Second Year

Near the end of April, 1980 we returned to Forestview for the third time. Shortly after the October visit, work on the project had again resumed. No further cash shortfalls had occurred and it appeared as though the project might get back on its overall schedule. We were interested to see the extent to which the Science Institute and the project had recovered from the setback.

New Impressions of the Science Building

On walking in the door of the Science Building this time, the visitors were immediately struck by two things: space and color. The firewall had been removed (it was unnecessary in an all-concrete building) and the stairway reopened to the various floors to create the kind of grand foyer it was originally designed to be. The stairwell itself was divided into three bands of color: a kind of mauve, blue and green. Each band wound around the stairs to a particular floor where that color became the theme of an all-encompassing color scheme.

Once we walked down one of the hallways, the impression became one of chaos because the hallways had become the storage area for all equipment and furniture moved to accommodate renovation work. Meanwhile, the best that could be said for most of the classrooms and laboratories was that they were "in progress". Thompson's carefully laid plans to conduct the renovations without too much disruption to classes had obviously not worked out.

In the midst of this disruption, however, some rooms were nearing completion (including the CAUSE-funded environmental chemistry laboratory) and these rooms were quite striking. Following the principle set by the decision to renovate the laboratory benches rather than replace them, the laboratory and classroom appointments gracefully and economically combined the best of the old and the new. Refinished original oak cabinets and blackboard moldings were matched with new cabinetry, where necessary, of similar materials. Many of the building's original fixtures had used brass hardware and this hardware had been polished and given a protective coating. Laboratory benches were certainly as good as new, and perhaps better. Modern lighting, floor treatments and painting schemes completed the picture. On the whole, these rooms were some of the most distinctive instructional spaces either of the visitors had seen. Somehow they seemed to symbolize a unique part of the philosophy of this college.

Overview of the Visit

It, again, was a beautiful spring morning as we walked across campus to meet with Paul Thompson. As we entered the Science Institute offices, we were greeted by chemistry professor and CAUSE team member, Robert Young. He immediately asked us if we had been out to tour the nearby woods where the trilium and columbine were in bloom. (Later in the morning, a faculty member in mathematics excitedly discussed the trilobite-collecting possibilities in the area. What better faculty for environmental science could there be than one who combine interests in chemistry and columbines or t-tests and trilobites?)

Paul Thompson was also in the office, and while Young was describing area flora, Thompson was preparing a sign which he posted by the door:

> The Peter Principle:
> A person will rise to his/her level of incompetence.
>
> The Forestview Principle:
> A person will get buried in work to his/her level of incompetence.

When asked to explain the sign's significance, Thompson replied that his various responsibilities as CAUSE project director, Science Institute director, full-time faculty member and coordinator of the building renovation had finally worn him out. Unable to obtain any relief from these responsibilities, he had just resigned from the CAUSE project directorship. For the case study team, this event came to symbolize one of the themes of this visit: the CAUSE project and the college were moving ahead again, but only at considerable cost to some of the individuals involved.

This visit was the busiest of the three. First of all, there was more to see of the project itself. Some of the building renovations had progressed far enough to allow before-and-after kinds of comparisons. Several CAUSE-developed courses were being offered (and evaluated) for the first time. A number of equipment purchases had been completed. Second, we wanted to conduct a new round of interviews with the five faculty most closely involved with the project at this time (including two faculty who had picked up the project responsibilities of faculty no longer at Forestview). Third, we were more concerned than ever with understanding how the changes at the Science Institute looked in the context of the college as a whole, so an additional series of interviews was planned with faculty from other academic areas and with the academic dean. Finally, we needed to spend considerable time with Thompson both to check our perceptions of the project's activities and outcomes to date and to specualte about its final outcomes in the third year. (In certain areas of project activities, we were beginning to have an influence on Thompson's view of the project and before we left he thanked us for providing him with an opportunity to reflect on his experiences as project director.)

Activities and Outcomes

The implementation of project plans had really begun to gather momentum during the winter quarter. Project faculty and other members of the Science Institute were more involved in the total project. The start of the building renovations and beginning deliveries of new equipment had seemingly initiated a new round of planning for the future, sharing of research and teaching ideas, etc. One example of such activity arose when the biologist was able to obtain his equipment for an aquatic environment field monitoring station at a considerably lower cost than was originally budgeted for the items. This led to discussions between Brown and Tyler as to the possibility of adding a weather monitoring station on the field monitoring system thereby providing for an interface between Brown's biology and Tyler's solar energy courses.

While there was a lot of evident activity and progress on the project, there also were some disturbing counterpoints. Most notably there was the growing disaffection and "burn-out" of Thompson and Andrews (the technical assistant), the two people most directly responsible for the day-to-day operation of the CAUSE and Kresge grants. During the period of this visit, Thompson was actively considering arrangements for a leave of absence during the coming school year. Other problems were arising in the relationship of the contractor for the building renovation and the Science Institute faculty: at one point a faculty member had to threaten physical violence before the contractor would agree to discuss an important design decision. Finally, plans for the computer purchase were still in flux and showing signs of becoming a hotly contested issue. In short, things were brewing in the Science Institute and the CAUSE project was beginning to make its mark.

One way to describe the project's accomplishments at this point is by describing progress within each of the project's functional areas. The fifteen or more different activities listed in the proposal can be summarized as seven functionally different efforts: curriculum/course development, equipment purchases, computer purchase, faculty development, facilities renovations, evaluation and project management. In each of these areas, the project's outcomes, strengths and weaknesses to this point can be reviewed.

Curriculum development. Of the eight courses to be developed or revised, four had been completed and offered for the first time, two had yet to be developed due to a faculty member's planned leave, and two were of uncertain status due to the unexpected departure of project faculty. From the comments of faculty and the logical necessity of prerequisite equipment purchases, it is certain that none of these courses would yet exist if it had not been for CAUSE funding. Furthermore, the increased emphasis on quantitative techniques that these courses represented was judged by everyone involved to be a fundamental improvement in the environmental studies program.

Aside from the uncontrollable effects of the loss of nearly a third of the project's original faculty, curriculum development efforts had proceeded pretty much as planned. Attempts were being made to overcome the loss of faculty and to complete the remaining course development activities. There were several areas, however, in which weaknesses in the planning or conduct of development efforts lowered the potential effectiveness of those efforts.

The first weakness was in the communication and cooperation of faculty working on individual courses within a common interdisciplinary curriculum. Potential benefits and the inherent logic of such coordination was obvious to the faculty involved, but the difficulties of getting the faculty together in one place, getting them to resolve certain philosophical differences, and overcoming Forestview's strong tradition of faculty autonomy were simply too great to be easily overcome. The project director expressed considerable frustration over this state of affairs but even the original proposal development effort had not required faculty to integrate their ideas into a common curriculum. The lack of communication was most apparent in the project's first year. By the second year faculty were reporting an increased sharing of ideas and resources across their environmental science courses. Hopefully, this communication can be maintained when new faculty become involved in the project to replace those who left.

A second possible weakness of the project was its limitation to the physical sciences. A truly comprehensive CAUSE project would have included the social sciences, particularly since they do have a recognized role in the overall environmental studies program. Perhaps due to the history of the proposal's development or traditional assumptions as to NSF's funding priorities, none of the physical or social science faculty interviewed by the case study team had given much thought to the inclusion of additional disciplines in the project. From one perspective, however, it could be argued that a certain amount of exclusivity was warranted: a more comprehensive project might have stretched the available resources so far and made project management so difficult that the impact of the grant would have been seriously weakened. (As it was, the project was quite comprehensive on another dimension, that of the variety of its improvements to the physical sciences.)

A final weakness in the implementation of the project's curriculum development activities involved the provision of release time. Given the organic nature of Forestview's academic life, no reduction of one-third of a faculty member's formal responsibilities was likely to result in any real increase in time available to do something new. For example, while a faculty member was released from teaching one course during the quarter in which he was developing a new course, he did not work with any fewer students: those students not enrolled in his one remaining course were likely to arrange an independent study. Course development activities simply had to be "fit in" around other responsibilities. Perhaps the only way most faculty would realize a real change in the time available for curriculum development would have been to reduce their formal responsibilities by two-thirds or more.

Equipment purchases. The purchase of scientific equipment would seem to be a very straightforward task. At Forestview, however, it was a time-consuming effort. It was time-consuming because of the consideration given to every purchasing decision. A conscious effort was made to avoid gadgetry for its own sake and, instead, to assess how particular instruments could serve local needs. Visits to other institutions, queries of local equipment manufacturers and users, catalogues, and expert advice were all considered in an attempt to make the most useful and economical purchase possible. These efforts seemed to be paying off. For example, Andrews reported that they had been able to obtain aquatic monitoring equipment that was not only $12,000 less expensive than originally budgeted but it was also expressly designed and manufactured to fit Forestview's requirements.

This kind of effort took a great deal more time than anyone anticipated and slowed the overall timetable for these purchases by as much as a year. It was particularly hard for faculty who were not regularly in the market for such things to obtain information on equipment options. Not knowing where to begin, it was difficult to conduct an efficient or systematic information search. On several occasions, serendipitous events seemed to play a determining role in the final decision. By the end of the second year the following equipment was in place, on order, or in the process of installation: aquatic monitoring unit for Brown, microprocessors for Tyler, well logging equipment for Thompson, and some audiovisual equipment. A few equipment purchasing decisions remained.

Due to the stage of project implementation, it was impossible to document any student outcomes of equipment use, but both faculty and students believed that the equipment would be heavily used across many courses and provide highly effective instructional experiences. The one exception to these positive predictions might involve the use of the recently purchased audiovisual equipment. The Science Institute had lost the two faculty most closely involved in the application of instructional technology (Upton and Moore) and there were some signs during our visit that this equipment might now remain locked up and forgotten.

Computer purchase. The biggest equipment purchasing decision of all had yet to be made as of spring of the second year. Project members were giving even more attention to this decision than had been true of the other equipment purchases. To complicate matters, however, the technology and cost of computer hardware was changing extremely rapidly and the project had unexpectedly lost the services of the Science Institute's only computer scientist. Meanwhile, there was some disagreement among the faculty as to the capabilities and functions the computer needed to possess.

Throughout the project's first two years, a variety of efforts were made to resolve the computer hardware situation. Attempts were made to find used equipment, generate hardware contributions and matching grants and generally to extend the impact of the $30,000 budgeted for hardware in the CAUSE grant.[5] While minicomputers that would serve the project's requirements were available in this $30,000 price range, the general need of the college and the Science Institute for an upgrading of available computer services was so great that everyone was concerned with getting the most out of the purchase. Options under consideration have ranged from an APPLE microprocessor to a DEC 11/70 with 16 terminals.

As of this third visit it was very difficult to predict exactly how the computer purchasing decision was going to turn out. From the perspective of the CAUSE project, it was hard to tell who even had ultimate control over the decision. Most of the project faculty were concerned that, first and foremost, the computer would serve the purpose for which it was intended in the grant. Meanwhile, other members of the college community (particularly administrators) saw the CAUSE money going towards the purchase of equipment for a revitalized college-wide computer center that would provide both academic and administrative computing services. Some project faculty, however, were worried about the decreased access for their needs that might result from this latter arrangement. The final decision was still in the future and a number of other options might arise before an agreement has to be reached among everyone concerned. As of this visit, however, the computer purchase was an emerging and increasingly important subject of discussion. Furthermore, if a decision was not reached soon, it would be difficult for the project to complete some of its computer-related activities before the grant period ran out.

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[5] Evidence of some of the efforts was documented in the project's first progress report to NSF and in a memo dated February 25, 1980 from Jim Hempstead in the Development Office.

Faculty development. As a formal area of project activity, faculty development primarily involved computer skills. Since the project's computer scientist had departed and the hardware had yet to be purchased, there had obviously been little progress in this area. But Forestview faculty do not give up their plans easily and several had begun to develop their own skills independently through course work and private study. While the project's original plans for this area seemed unlikely to be carried out, the desired end in terms of faculty competencies was still obtainable--once the hardware was available.

Facilities renovations. This aspect of the project was, potentially, its greatest success story and may have the most to do with long-term improvements to the quality of Forestview's science education program. As explained earlier in this report, the CAUSE budget for this activity was increased more than tenfold with the help of the Kresge grant. Now, instead of renovating a single, environmental chemistry laboratory, fifteen laboratories, classrooms and associated instructional areas (as well as hallways and restrooms) were being restored, renovated or re-equipped. A few rooms were being returned to functional instructional use for the first time in ten or twenty years. Table 21 outlines the scope of the current restoration/renovation effort. A second phase is planned (costing an additional $320,000) to restore the remaining areas of the building.

Table 21

Summary of Forestview's Science Building Restoration

Item	Amount
General Building	
Exterior repairs	$27,723
Rebuild main air handling unit w/controls	54,876
Halls, stairs, and entrance remodeling	9,772
Install new elevator for handicapped	50,000
New electrical panels three floors	5,500
Replace main distribution panel	5,700
TOTAL General Building	$153,571
First Floor	
Chroma chemical rooms	$ 2,160
Chemistry lecture room	3,858
Chemistry conference room	2,381
Laboratory preparation room	5,936
Analytical chemistry laboratory	55,996
Chemistry stock room	9,008
Convert men's room to men's and women's rooms	27,142
New solar energy laboratory	7,761
Audio	1,039
Remodel wood and metal shop	3,641
TOTAL First Floor	$118,922
Second Floor	
Chemistry lecture room	$23,082
Organic chemistry laboratory	55,754
Physics laboratory	12,009
Physics classroom	4,220
Physics conference room	2,580
TOTAL Second Floor	$97,645
Third Floor	
Biology animal room	$ 5,637
General biology laboratory	16,282
Cell biology laboratory	10,916
Verterbrate biology laboratory	11,421
Histology laboratory	6,372
Aquatic environment laboratory (new)	12,860
Women's restroom	11,395
Map room	7,748
Earth science laboratory	11,796
Geology laboratory	10,397
Third floor conference room	1,738
TOTAL Third Floor	$106,562

Table 21 (cont'd)

Item	Amount
Fourth Floor	
Fourth floor walls and stairway to roof repair	$ 5,152
Audiovisual room	769
Men's and women's restroom	144
TOTAL Fourth Floor	$ 6,065

	$153,571	General Building Total
	118,922	First Floor Total
	97,645	Second Floor Total
	106,562	Third Floor Total
	6,065	Fourth Floor Total
Contract Cost for Bldg.	$482,765	
Contingency Allowance	11,679	
Architectural fee	39,556	
TOTAL restoration	$534,000	

While the bulk of the renovation efforts were only tangentially related to the CAUSE project per se, Thompson directs both grants and there had always been a certain overlap between the two projects. Unfortunately, this overlap has had its negative as well as positive sides and it was partially the frustration Thompson experienced in implementing the building renovations that resulted in his general burnout as a project director.

The issue of authority has presented the main difficulty with the implementation of building renovation plans. A local contractor/architect who is also a trustee of the college was hired to conduct the renovations. Unfortunately, this person tried to serve two possibly conflicting roles, that of contractor's representative to the college and the college's representative to the contractor, with the result that the Science Institute faculty often had been left out of the planning and decision-making processes. No information on budgets, work schedules, or design options had been provided to anyone, including Thompson. Design modifications and purchasing decisions were only inferred after the fact when faculty saw such things as a planned eyewash station omitted or a hood meant for an inorganic chemistry laboratory installed in an organic laboratory. Communication between the contractor and the Science Institute faculty had been so poor that in one instance a faculty member had to call the contractor/trustee on a weekend and threaten to destroy a particular aspect of the renovation work before the contractor/trustee would confer with the Science Institute about the particular design decision.

The Science Institute faculty were upset. While they were excited to see their building receive some long-deserved attention, they became frustrated when they saw their limited funds apparently being used inefficiently or for low-priority items. The faculty turned to Thompson and Thompson tried to influence the plans of the contractor/trustee. According to Thompson, however, such efforts had proven futile as the contractor trustee, "literally does not listen to us on anything." For Thompson and the others most closely associated with the building renovation effort (Andrews and Bell), attempts to monitor the quality and progress of renovation work and influence the plans of the contractor/trustee had required up to one-third of their time on top of their other responsibilities in the middle of the school year. In short, it had become a thankless, frustrating job that Thompson and the others would be glad to be rid of.

Evaluation. The project's proposal outlined a reasonably comprehensive set of formative and summative evaluation activities. As of spring of the project's second year, implementation of the formative evaluation effort was on schedule. A student assistant was working with Thompson to develop a four-page questionnaire to be completed by students taking the newly developed environmental science courses. The questionnaire was designed to be offered at the end of the semester and required students to rate various aspects of a course's lectures, discussions, readings, computer work, etc. This instrument was to be used for the first time during the spring quarter but even then there was discussion of the possibility of extending the use of this course evaluation instrument to other Science Institute courses not covered by the CAUSE grant.

The eventual, successful implementation of summative evaluation plans was somewhat uncertain at the end of the second year. The biggest problem was one of available expertise. Originally, a member of the social science faculty, Ralph Graham was to serve as project evaluation consultant. His services were subsequently lost to the project and no replacement was found. In the Forestview tradition of never letting any resources go to waste, however, Thompson spent some time questioning the case study team about evaluation methods. He has also looked to NSF for guidance, but has received conflicting messages on the role and nature of evaluation (from an NSF workshop on evaluation and the CAUSE project director's meeting). Eventually, in spite of difficulties in obtaining help, it seems likely that some form of the planned summative evaluation effort will be carried out.

Project management. In a project whose activities are as widely varied as this one, project management became critically important to the maintenance of a coherent approach to the project's objectives. The original proposal recognized the complexity of the management task and allocated between one-ninth and two-ninths of Thompson's time each year to this effort. What the original proposal did not recognize in its management plans was the necessity for one-person control and direction of the project. Much more of the decision-making and day-to-day management responsibilities had fallen on the shoulders of the project director than were originally anticipated. In addition, the arrival of the Kresge grant and the college's financial crisis complicated CAUSE project management and increased Thompson's related responsibilities as Director of the Science Institute. Overall, Paul Thompson has had to put in many long, hard weeks in attempting to fulfill all of his various academic and administrative responsibilities.

Given the demands being placed on the project director, the question arises as to the nature of the recognition and support that Thompson had received for his efforts. Within the Science Institute, Thompson's contributions had been widely recognized: He has been generally credited with being personally responsible for the successful CAUSE and Kresge grants. Outside of the Science Institute, however, Thompson's accomplishments were less well-known. In particular, the college's administration had accorded him only a minimal amount of support and recognition. When Thompson requested a lessening of his regular responsibilities to accommodate CAUSE project management demands, he was told that this was impossible. After a year of trying to meet all of his responsibilities, Thompson became so frustrated that he went to the dean to resign from his optional appointments as area chairperson and director of the building renovations. The dean argued against these resignations on the basis that the college was about to go through an accreditation review and could not afford a change in leadership in the sciences at this time. Instead, the dean suggested that Thompson hand the CAUSE project over to someone else. Thompson agreed to this compromise reluctantly as the CAUSE project was his most personally rewarding activity. These discussions with the dean took place shortly before our last visit to Forestview and precipitated Thompson's posting of the "Peter Principle-Forestview Principle" sign. At the time of our visit it looked as though the CAUSE project and the Science Institute would have new directors next year. Thompson was talking about taking a leave of absence from the college.

Conclusions. In spite of some difficulties in project implementation, the CAUSE project's overall status near the end of its second year was extremely favorable. A number of difficulties had been overcome and the project appeared capable of achieving or surpassing most of its original objectives. We continued to be impressed by the extent of this project's impact on the quality of one institution's science education efforts.

Forestview faculty seem to have an intuitive sense of how to make the most cost-effective and cost-beneficial use of a grant such as this. Unfortunately, the project was resulting in more negative than positive consequences for the project director himself.

Prospects for the Future

This report was written in June, 1980 several months after the final visit to Forestview. The project still had one year to go, and possibly longer if Forestview requests an extension. While the project appeared to be making good progress, there were several areas in which some uncertainties remained which could have an important impact on the project's final outcomes. First and foremost among these uncertainties was project directorship. At the end of the third visit, it seemed that the directorship of this project was about to change hands and, along with the question of who the new director would be, was the question of whether it was possible to have an effective transition of leadership in the middle of a project. (The experience of other CAUSE projects suggests that it is extremely difficult to accomplish such a change without some negative consequences for the outcomes of the project.) In a telephone conversation with Thompson in June, however, we learned that he had decided not to resign as project director. Instead, he had resigned from most of his other duties at the college and was going on two-thirds leave next year. His only remaining responsibilities were to direct the project, revise and teach his CAUSE course, and conduct the project's evaluation activities. During his release time, Thompson will work on developing a private consulting business. In this area, then, the project's future is secure, but the college may yet lose the services of one of its more productive faculty members.

A second area of uncertainty with implications for the success of the project's third year is project staffing. During the third visit it appeared that Professors Wallace and Young were assuming the project responsibilities of Professors Caldwell and Upton respectively. During conversations with Thompson in June, we learned that these staffing changes were now official. Furthermore, Hopewell, the biology professor and project member who had been on leave since the project's first year, was now returning to Forestview and would complete his CAUSE course development activities. Hopewell was also going to be the new director of the Science Institute, so someone associated with the CAUSE project would still be filling that key administrative post. The completion of Kresge grant activities were now to be primarily the responsibility of another member of the Science Institute, Bell. Thus, all the various responsibilities that Thompson had carried alone during the project's first two years were now divided among three people.[6] Project staffing and related arrangements, therefore, look appropriate for a successful third year.

The third and final aspect of the project which remained to be resolved was the computer purchasing decision. As described earlier, this decision appeared to be becoming an issue at the end of the second year. Specifically, some people were considering buying a microprocessor that would just serve the Science Institute's needs while others were considering using CAUSE funds as seed money in the purchase of a new, centralized facility which would serve the needs of the whole college. At the present time, it is difficult to predict the final direction of this purchasing decision. If the decision is made to obtain a new large computer for the college, the attainment of some project objectives is likely to be delayed. Overall, however, prospects for the successful completion of the project are good.

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[6] As an aside, we asked Thompson whether there were any advantages to having the Science Institute and CAUSE project directorships in the same hands. He said that he felt that the Kresge grant would not have been obtained if the situation had been otherwise.

Project Costs

Among this project's notable characteristics is its creative use of resources. The use of CAUSE money as seed money for obtaining further grants and some particularly ingenious purchasing decisions have already been mentioned. This section of the report focuses exclusively on the project's use of its resources within each of the primary functional areas of project activity (curriculum development, facilities renovations, etc.). It then discusses those aspects of the project's resource utilization patterns of particular relevance to other CAUSE projects. The analysis of project costs begins with a brief review of the procedures used to gather cost information.

Procedures

One member of the case study team, Richard Lent, served as the cost analyst for this case. Most of the information on the planned and actual utilization of project resources came from a series of interviews with the project director. Information on equipment purchases and the costs of certain personnel activities were derived from discussions with the project's technical assistant or the faculty members involved. These interviews were conducted during the October, 1979 visit with additional information collected during April, 1980. A further major source of cost information was the various documents prepared in support of the Kresge grant and in the continued efforts to obtain a better computer.

Presenting a clear and comprehensive cost analysis of this project has been particularly difficult due to the diversity of project activities and the overlapping nature of many of these activities with other activities (including other grants) at the Science Institute. As a result, no attempt has been made to present one picture of the project's overall utilization of resources and, aside from a brief review of the original budget, the focus of this cost analysis remains at the level of the six areas of this project's functional activities. These areas of functional activity were clarified with the project director and were used as the basis for this report's foregoing review of project outcomes. Specifically they include curriculum development, equipment purchases, computer purchases, faculty development, facilities renovations, evaluation and project management. Each area is treated separately under the results section below.

Results

The project's original budget as contained in the proposal is presented in Table 22. Reorganizing the project's total direct operating costs by area of functional activity produces an interpretation of the budget as shown in Table 23. Thus, the project's largest budgeted functional activity is equipment purchases with 37% of the total budget. Curriculum development and facilities renovations come second and third

Table 22

Forestview's CAUSE Project

Original Proposed Budget

Line Item	NSF	Forestview	Total
Salaries, Wages and Benefits			
11. Director.	$ 3,402	$ 2,701	$ 8,103
12. Professional Staff.	24,409	12,205	36,614
13. Assistants, Technical	4,075	2,037	6,112
14. Assistants, Student	17,744	8,872	26,616
15. Secretarial and Clerical.	9,333	4,667	14,000
16. TOTAL: Salaries and Wages.	60,963	30,482	91,445
17. Staff Benefits (when charged as direct costs)	13,412	6,706	20,118
18. TOTAL: Salaries, Wages and benefits (16 & 17).	$ 74,375	$ 37,188	$111,563
Other Direct Costs			
20. Staff Travel.	491	246	737
22. Laboratory & Instructional Materials. . . .	95,093	47,546	142,639
23. Office Supplies, Communications	867	433	1,300
24. Consultants	2,667	1,333	4,000
25. Workshops	2,400	1,200	3,600
26. Evaluation Expenses	1,333	667	2,000
27. Laboratory Renovation	28,515	14,257	42,772
28. TOTAL DIRECT COST.	$205,749	$102,870	$308,611
29. INDIRECT COSTS	$ 35,651	$ 17,826	$ 53,417
30. TOTAL COST OF PROJECT.	$241,392	$126,696	$362,088
31. TOTAL CONTRIBUTED BY INSTITUTION . . .		$126,696	
32. TOTAL AWARD FROM NSF	$241,392		

Table 23

Forestview's Proposed Budget by Functional Activity[a]

	Areas of Functional Activity						
Budget[b] Line Item	Curriculum Development	Equipment Purchases[b]	Computer Purchase	Faculty Development	Facilities Renovations	Evaluation	Project Management
11. Project Director							$8,103[c]
12. Faculty	$36,614						
13. Technical Assistant		$6,112					
14. Student Assistants	26,616						
15. Secretary							14,000
20. Staff Travel							737
22. Laboratory Instructional Materials		105,809	$36,830				
23. Office Supplies							1,300
24. Consultants	4,000						
25. Workshops				$3,600			
26. Evaluation						$2,000	
27. Laboratory Renovation					$42,772		
28. Total Direct Operating Costs (Including Benefits)	81,141	113,266	36,830	3,600	42,772	2,000	28,503
-- Total Direct Operating Costs as Percent of Total Budget[a]	26%	37%	12%	1%	14%	1%	9%

See Footnotes on the next page.

Footnotes to Table 23

[a] This does not include indirect costs.

[b] The only personnel time shown for equipment purchases is that of the Technical Assistant since he is the only person with an explicit responsibility to devote time to this area. He also has some responsibilities for the computer purchases and facilities renovations. Faculty also devote some of their curriculum development release time to this area but the specific nature of this responsibility is not explicit.

[c] Project Director's time is presumably divided in some way across the project's various functional activities although no attempt is made here to show such a division. In a similar fashion the secretary's time could also be divided across other areas.

with 26% and 14% of the budget respectively. Considering the project's budget from another perspective, capital expenditures (lines 22 and 27 of the budget) account for 60% of the total funds committed to this effort.

The CAUSE project funds are only part of the resources presently committed to improving Forestview's science education capabilities. Working from the $43,000 allocated to laboratory renovations in the CAUSE budget, the Kresge Foundation's grant and the matching contributions of other donors has produced a total budget of $534,000 for renovating much of the Science Building's facilities. Thus, the total amount of funds currently devoted to science education improvements of all types is close to $900,000 and may reach around $1,000,000 if current efforts to use the CAUSE project's computer budget as seed money for an additional grant succeed. It should be noted that all of these additional funds are devoted to capital expenditures: no funds have been allocated to cover the personnel expenses of faculty and staff involvement in these various activities for curriculum development and project management time. The manner in which these various resources are being employed is described below by area of functional activity in the CAUSE project.

Curriculum development. Eight courses are to be developed and revised during the period of the CAUSE project. The development and revision stages are each expected to take one-third of a faculty member's time for one quarter of the academic year. CAUSE funds cover the cost of this release time by paying one-third of the faculty member's salary during those quarters he is working on the course.[7] The budget also supports student assistants to help with some course development activities. (Up to one-third of the technical assistant's time is specifically devoted to the CAUSE project to handle equipment purchasing and installation activities and these activities are often closely related to a faculty member's development activities.)

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[7] As is true with most of the project's budget categories, the actual source of these release time funds is a 2/3-1/3 mix of grant money and institutional contributions.

By April of the second year, four courses had been developed and offered for the first time prior to undergoing any necessary revisions. The major expense for all of these development efforts had been faculty salaries for release time. Generally, the amount of time actually spent by faculty in developing a course during that particular quarter was roughly equivalent to the allotted release time. This estimate oversimplifies the situation, however, as course development activities frequently began before the assigned quarter and there was great variance as to what constituted a third of each faculty member's "average" work week. Looking ahead to the completion of these four courses (through the revision stage), the total cost of each is expected to range between $3,100 and $3,900 (exclusive of materials and equipment).

Of the remaining four course development projects, two should be completed at a cost similar to the first four. The other two projects present more of a problem as the project had already paid for their development but the faculty members involved have since left the college. Given the individualistic nature of each faculty member's course development activities, it was almost impossible for other faculty to step in and teach these courses without redeveloping them. The project was presently refunding the development of the environmental chemistry course and current predictions are that this course will cost close to $7,500 by the time it is finally completed.

Equipment purchases. The most notable characteristic of this project's equipment expenditures was not what was spent, but what was saved. In spite of the fact that most equipment purchases were made at least a year later than originally planned, Forestview had consistently been able to obtain the equipment it required at a lower cost than originally budgeted. For example, the audiovisual equipment cost $8,000 rather than the original estimate of $10,000, and a new means of performing the desired aquatic environmental monitoring activities reduced equipment costs in this area by $12,000. In neither of these examples is there any reason to believe that the original cost estimates were inaccurate but, rather, that some very careful shopping along with technical advances resulting in simpler equipment have produced better buys. The hidden cost of this effort, however, has been the time spent by project faculty and staff in obtaining information and reviewing requirements prior to making their purchasing decisions. Depending upon the amount and sophistication of equipment to be purchased, some faculty have had to devote considerable time (amounting to a day to a week's worth of time over the first year) to this somewhat overlooked aspect of project activity.

Computer purchase. The most complex equipment purchasing decision of all had involved the choice of a computer. While specific hardware and software needs were identified and listed in the project's original proposal, the rapid advances in this technology and the college's desire to get as much with this money as possible had invalidated the original purchasing decisions. Therefore, various members of the project's faculty, other Science Institute faculty and certain college administrators had spent from several hours to a number of days of their time in researching the computer issue, developing proposals and contacting potential donors. The value of this contributed time was again a very real but unrecognized expense of the project.[8]

Faculty development. At the end of the project's second year, the $3,600 allocated for workshops to improve faculty computer and audiovisual equipment skills remained unspent. This was partly due to the absence of the faculty who were to conduct these efforts and partly due to the delay in the computer purchase. It was expected, however, that these activities would be completed as budgeted during the project's final year. In the meantime, several faculty had devoted some of their own time to personal efforts to improve their skills in these areas (specifically, computer skills).

Facilities renovations. The $42,772 of CAUSE project funds originally allocated to laboratory renovations had been spent pretty much as planned with one exception: the decision to renovate rather than replace the laboratory benches lowered the cost per bench to the point where four "new" benches rather than three were obtained. Specifically, it cost the project approximately $6,100 in materials and labor to renovate and reinstall an old bench as opposed to $8,500 to purchase and install a new bench.

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[8] Whether the value of this time should actually be estimated in dollars and added to the college's contribution in calculating the project's total cost, however, is rather questionable. If the project had been conducted as proposed, then these costs would not have been incurred. It is only the faculty's desire to further extend the project's impact that has led to this additional time demand.

Facilities renovations originally funded under CAUSE are, obviously, only a small part of the story given the $500,000 of additional renovations financed through the Kresge grant. A detailed cost breakdown of the total renovation effort was given earlier in Table 21, Summary of Forestview's Science Building Restoration.

The one cost that does not show up on either the CAUSE or Kresge renovation budgets is the value of the time required of college faculty, staff and, specifically, the project director to plan and monitor these renovation efforts. During the winter and spring quarters of the CAUSE project's second year, for example, Thompson spent an average of ten hours a week (in addition to his regular responsibilities) managing the building renovation activities. Several other members of the Science Institute's faculty and staff (particularly Young) have also devoted similar amounts of time to this effort.

Evaluation. The project had yet to spend much of its evaluation budget. A student assistant was receiving several hundred dollars (paid on an hourly basis at $3.10/hour) for work on developing a course evaluation instrumentation. The more elaborate and extensive plans for the project's summative evaluation await implementation in the project's final year.

Project management. The original proposal allocated from one-ninth to two-ninths of Thompson's time each year to project management responsibilities. As noted in several places in this report, project management had been a much more demanding and time consuming task than originally anticipated. Thompson's description of the time he had donated to various project activities since the start of the CAUSE grant suggests that the total value of the project director's time for three years could be conservatively estimated at almost twice the $8,103 actually budgeted. The amount of this donated time, however, is considerably larger than it would have been had the Kresge grant not been obtained. In fact, if all of the proposal's original plans had been followed exactly, then the project management demands would have been close to the original budget for this activity: again, it is the attempt to maximize the impact of the CAUSE grant that has resulted in unrecognized costs to the project's faculty and staff.

Discussion

Aside from the cost issues associated with the various areas of this project's activities, several general findings can be deduced from Forestview's experience that have potential relevance to other CAUSE projects. First, faculty turnover on development projects can be costly in a very real sense as the improvements are closely tied to the individuals involved. By comparison to the equipment purchase and renovations aspects of this project, the money spent on curriculum development is least likely to have long-term impacts upon the quality of science education at Forestview.

A second observation is that capital improvements take a considerable amount of personnel time to complete. In general, however, the time needed to research and insure the proper implementation of capital improvements goes unrecognized even though, in Forestview's case, this extra investment of time greatly increased the project's impact in a number of areas.

Third and finally, Forestview's experience suggests that there can be a conflict between the wise use of CAUSE funds and the plans of the original proposal. If Forestview had followed the initial specifications for the project, then it would not have the possibility of achieving the kinds of benefits to its science education programs that now seem likely to result from this project. The reason for this conflict between original plans and ultimate best uses of project resources seems unavoidable. It is simply that the nature of a grant proposal does not allow for the justification of budget items on the basis of predictions as to the availability of used equipment, additional grants and technological innovations--yet such possibilities may provide the most cost-effective means of using project funds. It is fortunate that the people on this project recognized that creative use of project resources was appropriate as long as the overall intent of the project remained the same.

Conclusion

It was the best of times and the worst of times for the college. If nothing else, however, NSF should view Forestview's CAUSE project as money well spent. In terms of CAUSE's ability to affect the quality of American science education, CAUSE program officers might well echo the sentiments of a well-known observer of higher education who argued in Change Magazine to "let a thousand [Forestview's] bloom."

THE ESTABLISHMENT OF A CENTER FOR INSTRUCTIONAL DEVELOPMENT IN A LARGE, RESEARCH ORIENTED UNIVERSITY

Site Visitors: Albert Beilby
Marvin Druger
John D. Eggert
John Penick

Primary Author: John D. Eggert

Preface

The CAUSE project at Ivy University has consisted primarily of the establishment of a Center for Instructional Development in Engineering (CIDE). The primary long-term goal of the CIDE has been to institutionalize a systematic approach to instructional development within the rather large and independent departments of Engineering. An important secondary and facilitating goal has been to increase the awareness of and positive attitude toward instructional development among faculty. The establishment of the CIDE has been used to achieve both these goals. Activities of the center have included the support of the instructional improvement projects of four individual faculty, and the implementation of a series of formal and informal staff development programs and activities for engineering faculty.

The challenge the project has posed to us, as site visitors, has been to understand the relationship of the various activities to the project's long term goal. At times, the activities have appeared to be fairly independent individual projects, unrelated to each other and only peripherally related to the project's ultimate goal. At other times, each of these activities could be seen as promoting the slow but steady movement toward the acceptance of instructional innovation by a broad base of individual faculty and administrators, and an increased use of concepts of instructional design in the development and implementation of instruction at Ivy University.

The project director at Ivy has felt strongly that a low profile approach to institutional change is most appropriate, particularly within a prestigious, research-oriented institution composed of strong and independent faculty. We as site visitors, at times, felt a more aggressive approach would have been in order. These differences of opinion have been discussed openly and frankly, and it is to the credit of the project director that he has fully cooperated with this study although he has not always agreed with our point of view. We hope that both perspectives have been fairly represented.

The names of faculty members, administrators, students, and the university have been changed to fictional names throughout this case study.

Introduction

Overview

The CAUSE project at Ivy University is a 3-year effort, beginning in the summer of 1977, to create a Center for Instructional Development in Engineering (CIDE) and to conduct related instructional development and evaluation activities. The CAUSE grant from NSF covers $250,000 of the proposed project costs of $420,000.

This report is based on a series of three visits over an 11-month period by two-person teams composed of an educational evaluator and a science educator. (The science educator on the team was switched after the first visit for logistical reasons.) The visits occurred during the last part of the second year and the first part of the third year of the project. A cost analyst visited the project on one occasion and also interviewed project administration and staff by telephone on several occasions.

The focus of the visits was on the implementation of the major components of the project. We looked specifically at: the Center for Instructional Development in Engineering (CIDE), curriculum development efforts in four specific engineering courses, a seminar and workshop series for staff development and the evaluation strategies designed to support the Center's efforts. The site visitors sought to understand the degree to which each of these components was implemented and to understand the relationships of each of the components to the other, to the university, and to possible future curriculum development efforts.

This report is organized into four major sections. This introductory section provides some background and includes a description of the university context. The next major section, entitled "Project Implementation" describes the rationale of the project and includes a description of the various components of the project. The third major section discusses the project from the perspective of four of the central issues of the overall program evaluation of CAUSE of which this study is a part. The final section describes and discusses the costs of the project and is followed by some brief summary remarks.

The University Context

Ivy University is the land grant institution for the state in which it is located. Its undergraduate enrollment at the beginning of the grant totaled approximately 24,000 students, almost one-quarter of them enrolled in one of the ten engineering departments. Enrollments in engineering have been steadily rising over the past ten years as the demands from industry have been rising. These same demands have led to a slight decline in total number of faculty and have been making faculty recruitment and retention somewhat difficult. The fact that Ivy's state allocations have not kept pace with the increases in enrollments has also added to the challenge.

In the face of increased enrollments, and given a strong institutional commitment to maintain faculty research activities, some efforts to increase instructional efficiency have been made by engineering faculty to develop self-paced, modularized and other less traditional approaches to teaching. The CAUSE project is seen as an opportunity to provide support to faculty interested in developing new and more efficient approaches to instruction through the development of a Center for Instructional Development in Engineering.

Project Implementation

Background

Ivy University's departments of engineering are unusually large, their combined enrollment being greater than that of many entire colleges. The individual engineering departments are also relatively independent. Most are physically located in separate buildings on the campus and, because of their size and complexity, there is relatively little communication and interaction among faculty of the several departments. Although the heads of each of the departments are administratively under the Dean of Engineering, much of the control of fiscal and personnel resources is delegated to each department head.

This independence of the individual departments has posed a challenge to the development of formal support for curriculum development efforts. Although a university center for instructional development has existed since before the CAUSE grant, it has not been actively used by engineering faculty. (This has apparently been due to its administrative and physical distance from the engineering departments.) On the other hand, the development of a center within a single engineering department would have lessened the likelihood of its being used by other departments. The response to this problem has been the designation of a portion of a new interdisciplinary building as the location for a center for instructional development. Physically separate from each of the engineering schools, it has been given administrative independence through the creation of a policy board composed of the heads of each of the engineering departments, the director of the library and an associate provost. The center has been funded, in part, through contributions from the budgets of each of the departments. It has been hoped that this combination of independence from and support by each of the departments will provide a workable balance of authority and accountability for the center.

The decision to create the center had not been definitely made before the writing of the proposal and, according to the project director, whether or not it would have been created without the CAUSE funds remains an open question. However, the proposal cites the administration's projected use of space in a new engineering building (two large areas had been set aside for a center) as evidence of a commitment to the concept. The CAUSE proposal described two principal objectives of the project. These were (a) to create staff and begin to equip a Center for Instructional Development in Engineering (CIDE), and (b) to use the CIDE to carry out three types of activities:

1) To support and partially fund four instructional development projects in the areas of engineering laboratory and design courses;
2) To provide for development of systematic peer course and curriculum evaluation mechanisms to augment available student evaluation mechanisms; and
3) To inaugurate an invitational seminar series on instructional development.

The Center

The CIDE is physically located in the new Vaser Engineering Center Building designed to house interdisciplinary education and research activities within the departments of engineering. The building was completed in early 1977 and funds from NSF for the establishment of a CIDE became available in July of that year.

The Center occupies approximately 4500 square feet of space in the approximately 80,000 square foot, three-story building. Located in two rooms, the Center has a materials development area and an experimental teaching/learning area. The materials development area--about 1500 square feet--has work space for four to six faculty members to engage in instructional development projects, prototype carrels equipped with video and slide/tape equipment, a conference area, and desks for the Center director, assistant to the director, and project secretary. Equipment available to faculty includes a copymaker, slide duplicator, drafting facilities (and graphics artists), transparency-maker and audio recording equipment. A portable video recording system is also available to instructional developers.

The experimental teaching/learning area, consisting of about 3,000 square feet of open area sectioned off with free-standing partitions and classroom furniture, was designed to accommodate three kinds of activities: small group activities, computer-based instruction, and tryouts of new individualized instructional materials.

The director of the Center, who is also the CAUSE project director, is on leave quarter-time from the electrical engineering department. He was chosen for the position because of his history in instructional innovations in electrical engineering and for his professional interest in instructional development. The fact that he has also maintained, as a prime professional focus, an ongoing teaching and research program in electrical engineering was important for providing the Center and its activities with academic and professional credibility according to many of his colleagues. The director views his position as temporary (i.e., for the duration of the project and a few years afterward) with the hope that other engineering faculty will also cycle in and out of the position as the idea of the center gains support among his colleagues. "Ideally," says the project director, "I should be working myself out of a job."

The director's responsibilities are to meet periodically with the Center's policy board, to assist faculty in their instructional development efforts, to encourage the use of the Center by faculty and to coordinate, supervise and manage the various activities supported by the Center.

The Center is also staffed by a half-time assistant to the director (the assistant holds a Ph.D. in English and a B.S. in Physics), a full-time secretary and a 10% time graphic artist. While the graphic artist is occasionally used to produce course-related materials, she reports that most of her efforts relate to the preparation of publications for faculty. This service was noted and appreciated by a number of faculty with whom we spoke.

In addition to providing support to the four curriculum development projects supported by the CAUSE grant, the Center also supports a series of short-term curriculum development projects during the summer (a continuation of a "President's Faculty Grant Program"), a program of evaluation of the Center's efforts and an invitational seminar series on instructional development.

A summary of center staff contacts maintained by project staff shows that Center staff have interacted with engineering faculty on instructional matters on the average of two to three times per day. These contacts have included a variety of types of activities ranging from answering simple questions on providing access to equipment to providing assistance on the redesign of course materials.

The primary role of the Center, according to its director, is to provide support and encouragement to faculty in the area of instructional innovation and development. The director feels strongly that instructional development should not be forced upon faculty, particularly upon highly qualified research-oriented faculty with well-established reputations in their fields. He also believes that it would be relatively difficult to exert such pressure on individual faculty for a number of reasons. Included among these are the director's lack of administrative authority over faculty, the independence of the departments of engineering, the independence of faculty, and the general overburdening of faculty due to heavy teaching and research loads.

In general, the Center maintains a low profile within the engineering departments following a policy of gradual institution building rather than one of rapid and radical change. The Center also practices an open door policy with faculty being made aware of the opportunities for assistance through announcements in faculty meetings, faculty seminars, newsletters, evaluation publications and the like. Anyone who has expressed an interest in working with the Center seems to have been actively followed up and supported. At the same time, those faculty who prefer not to become involved with the Center or with instructional improvement efforts have not been agressively pursued on the assumption that successful examples of the instructional improvement efforts of others would, in the long run, provide the most powerful arguments for the Center.

The initial focus of the Center was on the support of four instructional improvement activities already begun (or planned) for engineering faculty from four of the engineering departments. These activities will be described in the following sections.

Laboratory for Computer-Based Manufacturing Control

Current manufacturing procedures rely heavily on the use of digital computers for control of the movement and manipulation of manufactured articles. A typical example might be the production of a heavy piece of tractor engine which has to be lifted, drilled, re-positioned, planed, rotated and milled in a series of operations during the manufacturing process. While in the past each of these steps might be successively performed by a number of individuals, it is now possible to monitor and control the entire process with a single computer which operates drills, lathes, lifts, cranes and other manufacturing and handling equipment. The problem this presents to an engineering laboratory is that the equipment necessary to simulate this process is both expensive and dangerous, and it is impossible to use in an undergraduate classroom or laboratory setting.

The solution developed by Dr. Jackson, a faculty member in the Industrial Engineering Department, is to create small, low-cost demonstration models of industrial settings. The actual manufacturing equipment is simulated with Fisher Technics miniature building blocks which are similar to children's interlocking building blocks, but are more complex and include peripheral equipment such as motors, wheels, tracks, and the like. The modeled equipment is monitored and controlled by microcomputers (and custom-designed interface units) to simulate various industrial operations. For example, his most complicated project is a model of the

Caterpillar tractor assembly plant in Moline, Illinois. Each of six work stations (complete with tracks, conveyors, and rotating platforms) is programmed by pairs of students to simulate the Caterpillar manufacturing operation, with Jackson providing the interfacing programs to link all of the programs together.

The materials, although originally designed for use as children's toys, are expensive and their development, time consuming. However, faculty and students reported enthusiastic endorsement of the approach. The project has also attracted the attention of a variety of audiences from academic and industrial contexts and, according to Jackson, four or five other universities have begun to use the same ideas.

During the course of the site visits a number of senior faculty expressed some concern that Jackson's activities in instructional development were detracting from his research efforts and could work against his promotion and tenure. Several of his students voiced similar concerns, as did Jackson. In fact, Jackson did not receive a promotion, and toward the end of the second project year he had a graduate assistant rewire all of the microcomputers to insure their operability by others in his absence. Although he reports that he harbors no ill feelings about his involvement with the CIDE, he would not recommend getting involved in instructional development activities to a new assistant professor but would recommend instead a concentration on bench research.

Jackson feels that instructional development efforts will continue to be supported within his department, although he believes that many of his colleagues do not feel strongly about such activities. The head of the department reports that he had supported instructional innovation before the CIDE and would continue to support it, but also feels very strongly about the primacy of research in industrial engineering.

Materials Engineering Laboratory Instruction

The increased enrollments in engineering have placed a particular burden on the service laboratory courses provided to all of the university's departments of engineering by the relatively small Department of Materials Engineering. One course in particular originally used three of four faculty quarter-time to teach approximately 185 laboratory students. A particularly time-consuming role served by the faculty in this course was to present a 20-30 minute introductory lecture for each lab session.

This approach posed a number of problems. First of all, it tended to dilute the efforts of the relatively small materials engineering faculty, forcing them to devote less time to one-on-one assistance within the laboratory and to their other research and teaching duties. Second, it introduced unwanted variation of content into the basic laboratory course because of the variation in interests and backgrounds of individual faculty and staff members. Third, it introduced an unwanted variation in quality of instruction due to faculty differences and the difficulty of maintaining faculty interest in repeating the same set of basic material three to five times a week.

The solution to these problems has been the development of six 20-30 minute television tapes funded by the CAUSE project to be viewed by students at the beginning of each of six laboratory sessions. Although the number of graduate assistants assigned to the course is unchanged, the number of quarter-time faculty assignments has been reduced from three or four to one who monitors the instruction of all 185 students.

The tapes themselves are fairly straightforward, consisting primarily of a lecturer and supporting graphics--charts, illustrations, and photographs--developed in part by the CIDE. (The actual production of the tapes was done through non-CIDE facilities within the Vaser Building.) While portions of the tapes deal with the content of the course, they are intended to be primarily procedural. Each tape is available during the appropriate lab session so that students may review it while conducting the activity, if so desired.

The faculty member who has developed the tapes, Dr. Carlson, reports that there initially had been quite a bit of faculty opposition to the use of tapes in the classroom, due partly to a worry about being put out of a job but especially due to a belief that television is simply not the best way to teach a lab. He has overcome this resistance to a large extent through examples of the work of others (the CIDE director has been a help here because of his own previous and related work) and through the successful use of the six completed tapes. The faculty have particularly appreciated the partial relief from their large teaching loads which the tapes have provided.

The Department of Materials Engineering has made a practice of requesting input from students, both immediately after having taken a course and during their senior year, through a student evaluation committee system. (This latter approach is unusual in that the faculty regularly solicits, and receives, detailed and quite frank senior student perceptions of individual faculty performance.) The data indicate student acceptance of the tapes. Interviews with faculty have indicated that several faculty who were initially opposed to the idea grew to accept the approach. One of these has reported he might make some tapes on his own.

Carlson is continuing his interest in the development of alternative approaches in instruction. One project he is presently considering is the development of a self-paced course in quantitative metallography which will utilize a computer-controlled, motor-driven microscope. The mechanism will focus the microscope on specific, predetermined areas of a sample which the student will then observe as an instructional example or as part of a test. The director of the CIDE and his assistant contributed to Carlson's development efforts by participating in several brainstorming sessions about the course and providing technical assistance in the production of materials.

The tapes developed through CAUSE are presently being used regularly. They have been accepted by both faculty and staff and appear likely to be used for some time. The production of additional tapes has been considered, although limitations of viewing space may prevent this.

Computer-Assisted Design of Linkage Systems

Mechanical linkage systems are combinations of gears, pivots and linkages which, when activated, will move an object through a series of predetermined points. Examples of mechanical linkage systems are the series of arms, levers and pivots which open and close the convertible top of an automobile or that feed the paper into a printing press or duplicating machine. Calculation of the correct length of the linkage arms, the positioning of pivot points and the selection of gear sizes is a complex interactive process that may take weeks to complete through the use of protractors, compasses and mathematical formulae. The time it takes a student to work through a single problem limits his/her practical experience with mechanical linkage systems.

The solution to this problem, developed by Dr. Vargress, chairman of the Department of Mechanical Engineering, was the creation of a computer program for use on an intelligent, interactive computer terminal which allows students to specify gear radii, pivot points, and connecting link lengths to move an object from one position to another. As the parameters are specified (either through key entry or through the use of a light pen), the computer constructs the mechanism on the video screen. Once all the parameters are entered, the computer graphically simulates the action of the mechanism, moving it through its cycle, revealing whether or not the design is successful or if the mechanism would bind or otherwise malfunction if actually constructed. This program enables a student to work through several different problems in substantially less time than would be otherwise possible.

The development of the computer program for this activity has been carried out primarily by a graduate student in partial fulfillment of his master's thesis. The task has been somewhat challenging since no precedents have been available. The student has had very little previous programming experience and the equipment itself has had to be partially redesigned since it reportedly did not perform to the specifications the salesperson claimed it would. Nevertheless, the program seems to perform smoothly. It can be seen that particular attention has been paid to insuring that the program can be easily used by an uninitiated student, with ample help and guidance available on the terminal screen as needed.

Vargress reports that initial surveys of students indicate that the program will be well received, and present plans are to offer the terminal and program for use in an undergraduate mechanical engineering course enrolling approximately 100 students per semester. The large number of students will present some problems since there is only one available terminal, but it is hoped that careful scheduling will overcome this difficulty.

Study of Engineering Laboratory Courses

The fourth major faculty project supported by the CIDE is a study of engineering laboratory courses within the university's various engineering departments. The purpose of the study is to open lines of communication between the various persons involved in the design and implementation of laboratory courses and to develop recommendations on how innovations might be shared across schools. Specifically, the report makes recommendations regarding the application of innovations in other engineering schools to laboratory instruction in civil engineering.

Data about laboratory instruction have been gathered primarily through two approaches. One has involved informal observation of and interviews with various engineering department faculty members involved in laboratory instruction. The second has been to design and conduct a survey of graduating seniors in engineering regarding their impressions of laboratory instruction at Ivy. (This survey is actually a follow-up to another, more general, survey of graduating seniors, to be discussed later.) Dr. McDonald, a faculty member of the Civil Engineering Department, feels that the availability of evaluation staff through the CIDE has been particularly helpful. Dr. McDonald has also prepared a bibliography of laboratory instruction which he has distributed to engineering faculty. According to McDonald, the survey results will be documented and possibly submitted to the American Society of Engineering Education (ASEE) for publication.

McDonald himself is involved in innovative laboratory instruction. His own lab in civil engineering includes a variety of work stations at which students can observe and monitor various sorts of structural behavior. The lab stations utilize materials and equipment obtained through a variety of private sources and through university funding. McDonald feels that an institution such as the CIDE is important for the support of instructional innovation, particularly in a heavily research-oriented university. He feels that instructional development takes faculty time and the support of persons skilled in instructional development and the existence of a center such as the CIDE helps to guarantee the availability of such support when it is needed.

Other Support of Curriculum Development

The CIDE has sponsored a series of seminars and workshops (at times co-sponsored by the Office of Instructional Development of the School of Social Sciences and Education), led by innovators in instruction from outside the university. The workshops are designed to "stimulate faculty thinking and action" with respect to instructional development. Both engineering and non-engineering faculty have been invited to the sessions. Engineering attendance has varied between 10 and 15 faculty per session. Session topics included university lecturing, teaching problem solving, applied creativity and others.

One motivation for attending these sessions has been the summer instructional development program sponsored by the CIDE and funded through contributions of each of the engineering department's budgets. Each summer a number of faculty (approximately six) are funded at half-time to work on their own instructional development projects. One of the stipulations of the support is that the work be carried out on the premises of the CIDE so that its resources might be maximally used and so that individual faculty might profit from the support and encouragement of others. Faculty are encouraged to propose projects with goals that are achievable within the time provided; e.g., the redesign of two or three weeks of instruction, as opposed to merely beginning a project which may or may not be completed at some future time.

The project director intends to identify highly motivated faculty members during these summer sessions with the hope of obtaining for them quarter-time funding for continued work during the academic year. He believes that programs such as these are gradually leading to a change in attitude toward instructional development efforts. He believes that the step-by-step approach of involving faculty in instructional development efforts, followed by the support they need to continue their efforts, is likely to be the most effective long-term strategy.

Project Evaluation Activities

The evaluation responsibilities for the project have been handled by a representative of the university's measurement and research center and a member of the freshman engineering faculty who are both experienced in instructional research. The evaluation has multiple purposes, according to the original proposal, including "the assessment of various effects of project activities, from the narrow and specific to the very broad matters of project influence on, for example, curricula, faculty, and institutional arrangements."

The evaluation staff has been primarily involved in the administration of four formal surveys. A mailed questionnaire has been administered to all currently graduating seniors soliciting their opinions on undergraduate engineering instruction in general. A second, follow-up questionnaire focusing on graduating students' perceptions of the laboratory courses has been done in conjunction with Dr. McDonald's activities described earlier. A parallel questionnaire has also been administered to engineering faculty soliciting their views on the utility of various services and equipment available or potentially available to them through the CIDE. Finally, a survey of mechanical engineering students has been conducted to solicit their opinions of the content of a course in machine design and analysis. Other activities of the evaluation staff have included the occasional provision of guidance and assistance to individual faculty in the evaluation of their own materials.

Reports of the formal survey have been produced in a very attractive format and printed on good quality paper and have included photographs of the CIDE in operation. CIDE staff believe that the surveys provide an effective public relations tool for the center. Almost all of the 350 copies of the survey results have been distributed among engineering faculty.

The CIDE director has also developed a course evaluation guide which has been made available to faculty to assist them in identifying those aspects of their courses "which could benefit from an instructional development effort". While the guide has not been formally used by the faculty for evaluation, faculty have reported that is has been useful for curriculum planning. The project director also believes the guide has served to raise the consciousness of faculty members with respect to curriculum design issues.

Discussion/Conclusions

This section of the case study discusses the CAUSE project at Ivy University from the perspective of four of the central issues of the overall program evaluation of which this study is a part. These issues relate to the need for and institutional support of the project, implementation of the project, impact of the project and the role of evaluation in the project. The issue of project costs will be treated separately following this discussion.

The Need for and Institutional Support of the Project

There is a definite need for increased support of instructional development at Ivy University, particularly in the area of laboratory instruction. The increase in student enrollments and the decrease in available faculty require increased efficiency of instruction. The laboratory courses, which some faculty have indicated are most amenable to instructional innovation and which have been the focus of most of the faculty's instructional design efforts, have been cited by surveyed graduates as most in need of improvement. The faculty in general are heavily research oriented and many have never taken the opportunity to systematically think through the process of instructional design, and would not be inclined to do so on their own. While support for instructional innovation does exist elsewhere on campus, it is not used by engineering faculty because of the physical, psychological and administrative distance between the large engineering departments and the central campus facilities.

There has been some evidence of administrative support for the CIDE from the highest levels. The strongest evidence has been the designation, before the CAUSE proposal was submitted, of a large amount of space in a new interdisciplinary engineering department building for use by the Center. (However, the project director reports that he strongly suspects that without the CAUSE grant "the CIDE may have lost out to pressures to use our limited resources in other ways".) Other evidence includes the institutional contributions for individual faculty curriculum development projects, a practice begun before CAUSE and one which seems likely to continue after the grant expires.

It is apparent, however, that the needs represented by the CIDE compete for the attention of faculty and administration against other needs generally perceived as being of higher priority than instructional development. Two of the most clearly competing needs are the need to produce high quality research and the need to instruct increasingly large numbers of students. (Although the project itself seeks to address problems related to increased enrollments, the immediate need to instruct large numbers of students competes with the longer-term need to develop new approaches to these problems.) Attending to all three sets of needs is, of course, crucial to the mission of the university. The challenge is to determine and maintain the appropriate balance.

This competition can be seen in a number of ways. Many of the faculty most heavily involved in instructional development efforts as well as others on the periphery of the project frequently have commented that they feel their activities on the project tend to work against their advancement toward promotion and tenure. It is also felt that work in instructional development has not been highly regarded by the majority of their colleagues and that they have participated at some risk to the professional esteem of their peers.

Not everyone interviewed, particularly university administrators, agrees with the assumption that the need to do research conflicts with the need to create high quality instruction. The argument is made that the involvement of faculty in research necessarily leads to higher quality instruction and that the two needs are complementary and not competitive.

An important justification for the CIDE has been the increase in instructional efficiency it would provide the departments of engineering. Increased efficiency is felt necessary because of increasing enrollments and decreasing numbers of faculty. It is unfortunate that the problem, increased teaching loads, also partially mitigates against the implementation of the solution, the design of innovative instruction. While faculty have engaged in a variety of instructional development efforts, it is clear that resources of time and emotional commitment have had to be squeezed out of a fairly fixed pool. The CAUSE dollars have been used to fund release time, and the agreed upon hours have been put into the project by individual faculty, but it has been impossible to hire additional faculty to counterbalance the additional responsibilities for curriculum development. In many cases individuals' non-CAUSE instructional and administrative responsibilities actually have increased during the time they have participated on the project. An individual's commitment can only be divided so many ways, and the assignment of staff to instructional development projects without decreasing their actual formal and informal responsibilities for research, teaching and administration cannot yield the highest levels of commitment to instructional innovation.

This is not to imply that the faculty and staff of this project have not been committed to the concept of a CIDE. Quite the contrary; in light of the strong pressures to focus professional efforts in other directions one can only conclude that the commitment of individuals involved has been genuine and substantial. It is important to the understanding of this project, however, to recognize that the commitment of individual faculty and staff is not the only commitment necessary for project success. Institutional commitment is also necessary. In the opinion of this writer, the institution appears to have been either unwilling or, more likely, unable to provide a full commitment to the CIDE.

Implementation of the Project

The project was implemented as proposed, with the various mid-course adjustments that normally occur in an effort of its size and complexity. In particular, the two primary objectives proposed and attained were: (1) to create, staff, and begin to equip a Center for Instructional Development in Engineering, and (2) to use the CIDE to support four instructional development projects, to develop course and curriculum evaluation mechanisms and to inaugurate an invitational seminar series on instructional development.

While some would view the second objective as the primary objective, that would be a misinterpretation of the intentions of the project director. The development of courseware, the production of evaluation reports and the holding of seminars is perhaps the most visible aspect of the project. But many of these activities would have occurred at some level without the CIDE and, while each will have its own relatively immediate impact on the engineering departments, their long-term impact on the institution will be necessarily limited by changing curriculum requirements, faculty turnover and the like. The primary goal of the project according to the project director, has been the creation of a center for instructional design. In addition, it is the hope of the project director that the existence of the Center will lead to an increased awareness of instructional development and, ultimately, to the institutionalization of a systematic approach to the design of instruction.

The first step has been taken: i.e., the Center itself has been created, staffed and equipped as proposed. The project director reports he has also been emphasizing what he sees as the second step, i.e., increasing individual faculty members' awareness. As he puts it, "The goal of this project is to have faculty talking about instructional design over their coffee." Implementation of policies and activities to support the achievement of this goal has been substantially more difficult than staffing and equipping the Center or assisting in the development of materials for individual courses. The project director sees it as a much subtler process--it must occur gradually; and it is difficult to monitor progress on even a year-to-year basis. Yet, if successful, it will have a long-term and meaningful impact on instruction in the engineering departments. The challenges faced by the project are formidable, however. The competition for institutional resources among vital needs of the institution has already been discussed. Other challenges include the fact that most research oriented engineering faculty have not experienced nor become involved in formal instructional design procedures and they have seen little evidence that it is worth their effort. In fact, many can quite easily point out examples where attempts to design instruction according to formal development models have been counterproductive. The assumption that "excellence in research will lead to excellence in teaching" is widely held and was often used as an argument against an emphasis on formal instructional design activities. The lack of convincing precedents and the lack of colleagial support in instructional design efforts are also formidable barriers to the establishment of an operational center for instructional design.

The key implementation strategy of the project has been one of gradual attitude change through the setting of meaningful examples and the provision of positive support and assistance when initial steps have been taken. The credibility of the Center has been established through the appointment of a director who still retains three-quarter time responsibilities to his academic department. Plans are to continue this approach, probably rotating other faculty through the director's position from year to year. Faculty have been encouraged, but not pushed. As much missionary work has been done on an informal one-on-one basis as has been done in the formal seminar and summer programs.

It is difficult to assess the appropriateness of such a low-key approach. On the one hand, there is no evidence of faculty rejection of either the Center or its staff. On the contrary, most faculty interviewed have shown genuine respect for the Center's director and his activities. According to the project director, a more aggressive approach could have led to more negative reactions. On the other hand, 25% release time is insufficient to allow the director to provide the strong motivation, support and leadership that is necessary to keep a $140,000 per year project moving forward in the very complex environment of the large and relatively independent departments of engineering.

In this writer's opinion, the ultimate goal of the project director, i.e., the institutionalization of a systematic approach to instructional design, will be very difficult to achieve with the present CIDE staffing configuration. The project director has done a commendable job of tending to the administrative details of the project, of maintaining liaison with all the various faculty and administrators who have been politically and/or financially involved in the project and especially of developing and nurturing positive attitudes toward instructional innovation among interested faculty. However, the allocation of only 25% of the director's professional time (even with the half-time assistance of the assistant to the director) has made it impossible for him to institutionalize a systematic approach to instruction. The faculty and their graduate assistants, although assisted by CIDE staff as their time has allowed, have had to carry much of the acutal instructional development load themselves. It does not appear that the individual faculty developers have viewed this as a hindrance, but this is because they do not generally seem to be aware of the need for professional assistance in instructional development. However, the need is there, particularly if the high visibility, high impact efforts are to be developed, the type of efforts which can create a reputation for the Center among faculty and a justification of its existence to university administration. It would seem that plans for continuing the use of a part-time director who would fill the position on a temporary basis will not give the CIDE the aggressive direction it will need to continue forward.

Impact of the Project

The impact of the project can be discussed in terms of impact on the students, impact on the faculty and impact on the institution.

The project has had some impact on the students through the use of materials developed by the faculty. Data from observations and interviews suggest that the newly designed approaches have probably increased the quality of instruction, increased instructional efficiency, or both. Informal interviews by the site team with students indicated that the new approaches were, in general, well received. More extensive evaluation would be necessary to document the nature and extent of these impacts. However, the major impacts of the CIDE on students should be expected in the next few years, to the extent that individual faculty begin to adopt approaches to instructional design supported by the CIDE.

If one assumes that change in faculty instructional behaviors must develop through a cycle of awareness of options, positive regard for those options, and experimentation with the options before their actual adoption, then it can be argued that the CIDE has had a definite positive impact on faculty. Through the internal public relations efforts of the project director it seems unlikely that any engineering faculty member is unaware of the aims of the CIDE or the services the CIDE has to offer. No evidence was observed that suggested that the Center has created negative attitudes among any of the faculty, and there was evidence of positive regard for the director, the Center, and particularly for the development projects completed by the faculty. Approximately 35 individuals have actively participated in some sort of instructional development activity with the Center, and over 160 faculty have participated in the seminars. Most of the completed curriculum devleopment efforts seem to have a good chance for continued use. Some faculty have indicated a desire to begin new development projects, although the constraints on such activities are also recognized and will somewhat impede progress. While the project has not resulted in the production of as many instructional materials as some similar CAUSE projects have, and although the products are not as flashy as others might be, it may be the case that the CIDE has gone further than many in promoting faculty awareness of and positive attitudes toward the systematic design of instruction. It is too early to tell for sure. This is a long-term effort. Seeds have been planted, and there is definite healthy growth. However, real success may be some years away and many problems will be encountered in the interim.

Project Evaluation

The role of evaluation has been kept quite flexible through the project. Initially the proposal emphasized the establishment of a peer review system and a curriculum evaluation system suitable for providing specific feedback to individual instructors. Early into the project, however, it was recognized that the very process of sharing and openly discussing curriculum development activities with others is in itself threatening. One source of this discomfort is the belief that evaluation is necessarily implicit in such sharing. For this reason, according to project staff, the evaluation of faculty products has been downplayed and other roles of evaluation have been emphasized through the duration of the project. (Individual faculty still have availed themselves of specific CIDE evaluation services, depending on their own inclinations.)

The unique aspect of this project's evaluation activities has been formal and very professionally executed surveying and reporting of responses from graduated seniors and from engineering faculty. Although the surveys were fairly broadly focused and thus could have few specific and direct impacts on institutional planning and development, they apparently were widely read and undoubtedly stimulated thought about specific instructional problems and alternative solutions. In addition, according to the survey developers, each survey had something in it for everyone--every reader took some fact or figure away from the report that s/he felt was useful.

The production of the reports was so well done that the booklets served as public relations documents for the Center. They included descriptions of Center activities, photographs of facilities and personnel and lists of services and equipment available for use. Graphic illustrations of the data were well laid out and clear interpretations and discussions of the results were written. The questions asked and the illustrations and discussions of the results undoubtedly stimulated the curiosity and thoughtful discussion about the issues with which the CIDE was concerned. It is probable that these documents, if they did nothing else, achieved the CIDE director's goal of "faculty talking about problems of instructional design over their coffee".

Although some efforts were made, some successfully, to aid individual faculty in the formal evaluation of their curriculum development efforts, faculty were generally supported in their desire to conduct their own informal evaluations of materials through observation of the materials in use, the day-to-day monitoring of student opinion, the occasional review of materials by selected colleagues and other evaluation activities normally pursued by university faculty. Although the curriculum evaluation guide developed by the project director was apparently not extensively used on a formal basis, the hope was expressed by the project director that the concepts described in the guide would be adopted by individuals as they developed their own instruction. However, until curriculum development becomes a more public and systematic process, the use of more formal and systematic evaluation procedures in instructional development will be difficult.

Project Costs

This section of the report provides an analysis of the resources committed to the project. The costs of the resources are assigned to specific project activities according to their use. Procedures employed in data collection and analysis are detailed below, followed by tables of results. The results are then discussed in terms of project impact on the institution. This section was written by the project cost analyst, Albert Beilby.

Procedures

I visited the project site on July 23 and 24, 1979. Most of the cost data were collected at that time. Data relating to the project's final year were collected via letter and telephone during January and February, 1980.

Before visiting the site I reviewed the project proposal to become familiar with project goals. I then wrote the project director, outlining the purpose of the intended visit and describing the areas of functional activity (cost centers) which I perceived would be useful in describing project costs. These were discussed, modified slightly, and agreed upon during the first hour of the initial visit. Additional modifications were made during the course of the study. The following functional activities were used as a meaningful basis for cost analysis:

1. Instructional Development - the development of materials for use in the classroom or laboratory.
2. Administration - the planning and management of CIDE. Policy Board meetings are included in this function.
3. Evaluation of Materials - the formal and informal activities of project faculty and other staff to evaluate developing or developed materials.
4. Evaluation of the Project - all evaluation activities not included under evaluation of materials.
5. Dissemination - the planning and implementation of seminars and summer studies on instructional development.

Costs are also expressed in terms of content areas which reflect the departments involved in the project. The content areas are:

1. Materials Engineering (the focus is on individualized lab instruction).
2. Mechanical Engineering (the focus is on computer-assisted instruction for mechanical linkage design).
3. Civil Engineering (the focus is on improving laboratory instruction).
4. Industrial Engineering (the focus is on computer-based manufacturing control).

The academic periods covered are summer, 1977 and the 1977-78 academic year (Year 1), summer, 1978 and the 1978-79 academic year (Year 2), and summer, 1979 and the 1979-80 academic year (Year 3). Costs are reported by these periods.

This report focuses on personnel costs since experience has shown these are the type of costs most subject to unplanned fluctuations. Non-personnel costs are examined briefly in the report.

During the site visit, faculty and staff were asked to estimate the percent of time or the number of person-days they devoted to specific CAUSE activities for each academic period. This procedure provides more accurate information about how personnel costs are distributed than other available methods. Frequently, personnel spend either more or less time on a project than they or anyone else planned and they are the best judge of what they did and when.

Results

Table 24 reports the summary project budget as presented in the project proposal. Table 25 summarizes the personnel costs associated with CIDE activities. CIDE personnel represented by these costs include the project director, the assistant director of the Center, one secretary, and a graduate student. Several non-CIDE personnel are included in the evaluation function. These include faculty from the Measurement and Research Center, Engineering Education Research, and graduate students. Table 26 provides a breakdown of instructional development costs by departments. Table 27 reports personnel costs by project year and compares the costs with budgeted personnel costs.

Discussion

Relative to this analyst's experience, instructional development activities consumed a surprisingly small amount of personnel resources at 21.2% (see Table 25). Even when the evaluation of materials is added to instructional development, the amount (34.5%) is on the low side. This, in part, reflects the relatively low level of staffing of the CIDE discussed earlier in this case study. It may also be due to the fact that

Table 24

Ivy University's CAUSE Project
Original Budget Summary

Salaries, Wages, Benefits	
11. Director	$ 25,672
12. Professional Staff	97,101
13. Assistants	
14. Graduate Instructor & Graduate Assistants	62,100
15. Secretarial and Clerical	10,568
16. Total: Salaries and Wages	$195,441
17. Staff Benefits (charged as direct costs)	22,772
18. Total: Salaries, Wages & Benefits	$218,213
Other Direct Costs	
19. Guest Lecturers	7,800
20. Staff Travel	3,600
21. Field Trips	-0-
22. Laboratory Materials	-0-
23. Office Supplies	3,001
24. Non-expendable Equipment	46,050
25. Communications and Postage	3,600
26. Publications and Duplicating	3,600
28. Total Direct Cost	$285,864
29. Indirect Costs	137,982
30. Total Cost of Project	$423,846
31. Total Contributed by Institution	$173,846
32. Total Award from NSF	$250,000

Table 25

CIDE Personnel Costs[a]

l Activity	Summer 1977 and 1977-78	Summer 1978 and 1978-79	Summer 1979 and 1979-80	Total	% of Total
onal Development	$ 4,330	$11,820	$ 7,530	$ 23,680	21.2%
ation	8,410	9,850	6,960	25,220	22.6
n of Materials	4,150	3,320	6,230	13,700	12.3
n of Project	10,870	15,420	7,480	3,770	30.3
tion	2,780	3,290	9,140	15,210	13.6
	$30,540	$43,720	$37,340	$111,600	100.0%

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l costs include fringe benefits @ 21.5% of faculty/professional salaries.

the Center is new and not yet recognized as a source of instructional development expertise.

The program evaluation costs are quite high (30.3%). This high cost appears attributable to the fact that two senior faculty were involved for (usually) 10% of their time and they were supported by three graduate students (no more than two during any one semester). Furthermore, they required between 5% and 70% of a secretary's time when the evaluation required production work.

The nearly 14% of personnel cost attributed to dissemination efforts reflects the CIDE staff's efforts to increase awareness of and positive attitudes toward instructional design. These costs were particularly heavy during the last project year reflecting, in part, a more intensive effort with regard to seminars.

Focusing on the departmental personnel costs, nearly half of the content specific instructional development activity was attributed to Mechanical Engineering (see Table 26). This is partly due to 1) higher salaries, 2) greater levels of effort, 3) the use of more faculty, and 4) more CIDE staff time than was found in the other content areas. Materials engineering --the next most costly content area--also utilized non-budgeted faculty for a time. Approximately 15% of the instructional development activity was attributed to CIDE support staff involvement in instructional areas not specifically identified in the proposal; e.g., electrical, chemical and nuclear engineering. Many of these projects were related to summer studies but are classified here as instructional development rather than dissemination.

Dissemination, which was developed as a category in order to obtain a

Table 26

Instructional Development Costs

Content Area	Year 1	Year 2	Year 3	Total	% of Subtotal
Mechanical Eng.	$12,010	$22,210	$15,500	$ 49,720	45.0%
Materials Eng.	13,710	13,290	--	27,000	24.4
Civil Engineering	6,090	3,770	7,560	17,420	15.8
Industrial Eng.	5,970	8,250	2,100	16,320	14.8
Subtotal	$37,780	$47,520	$25,160	$110,460	100.0%
Engineering, General	3,480	9,220	7,530	20,230	
TOTAL	$41,260	$56,740	$32,690	$130,690	

Table 27

Estimated and Budgeted Personnel Costs

	Year 1	Year 2	Year 3	Total
Total Costs from Table 1	$30,540	$ 43,720	$37,340	$111,600
Design Costs from Table 2	41,260	56,740	32,690	130,690
Total	71,800	100,460	70,030	242,290
Less Common Costs[a]	4,330	11,820	7,530	23,680
Total Est. Personal Costs	67,470	88,640	62,500	218,610
Budgeted Personnel Costs	72,270	82,080	63,860	218,210
Difference	-($ 4,800)	$ 6,560	-($ 1,360)	$ 400

[a] Common costs are the instructional development activities of CIDE staff.

clearer picture of instructional design activities, was not a role of the principal faculty involved in the project. While a few attended a seminar or a study, the time was deemed too insignificant to isolate for this group. Dissemination involved Center staff to a much greater degree than it did faculty.

Table 27 compares personnel costs as they were budgeted for the three project years with the way they were expended. For the most part, personnel costs were expended as budgeted when the three years are taken as a whole although sizable annual deviations were noted. During the first year the late start of the Mechanical Engineering Program was responsible for a $7,000 salary "savings". This was reduced to a $4,800 difference as personnel time accrued faster than anticipated in other engineering programs. The third year difference may be due to the use of fewer graduate students than planned. These differences are nearly offset by second year contributions to the project in the form of 1) involvement of faculty not formally identified with the project (in Mechanical Engineering and Materials Engineering), 2) involvement of non-budgeted graduate students, 3) full-time use of a clerical staff person instead of the fraction budgeted, and 4) an increase in individual salaries exceeding the budgeted increases.

The $400 difference noted in the final year is quite small. The ratio of actual costs to budgeted costs is essentially 1.00. The ratio might have been higher had I been able to identify some donated time other than that given to principals formally provided release time on the project. A significant portion of Ivy's contribution was to have been release time for principal project personnel. However, as noted earlier in the case study, it appears that in many cases individual faculty were required to take on the CAUSE responsibilities in addition to their normal workload. To the extent that some of the work appears to have been accomplished through unpaid faculty overload, it may be more accurate to think of the university's contribution as a joint contribution of the university and its faculty.

Non-personnel costs were not closely examined on this project other than to note that they were not deviating significantly from the budgeted amount. Furthermore, at the time of the last data collection, there were three months remaining to the project and unencumbered non-personnel funds remained to be expended. Therefore, it is not possible to come to a firm conclusion about the amounts spent.

One intent of the cost studies associated with the overall evaluation of the CAUSE program (of which this study is a part) is to identify indicators of institutional support for the projects examined in each of the eight case studies. For example, many similar projects have exhibited some institutionally supported costs in excess of the budgeted amounts, or personnel have given extra time on their own, beyond the budgeted amounts. Excess contributions in these areas were not noted at Ivy University. Personnel involvement worked out almost precisely as budgeted, not even influenced by high inflation nor by at least one exceptional salary increase. This should not be taken as an indication of the institution's reneging on any of its formal commitments to NSF. However, it does seem to indicate less institutional support for the project than has been seen elsewhere.

The continuation of the CIDE will depend on the continued financial support by the institution. At the present the Center is partly funded from budgeted contributions of the engineering departments, and the director has one-quarter release time to administer the Center. His salary, as well as those of other project staff and participating faculty, will have to be picked up by the departments or by higher level administration for the Center to continue. The estimated value of the two rooms and their furnishings presently allocated to the Center is approximately $40,000. As long as the space is not needed for some other purpose, their use for the CIDE will not be a burden to the institution. However, the space allocation is easily reversible and will require institutional commitment to the CIDE if and when other priorities for space usage emerge. Present plans are for the Center to continue at some level beyond the expiration of the grant.

This continued support will undoubtedly be challenged at various points in the future of the CIDE, given the shortage of space and faculty time at Ivy University and given the care with which these resources can be reallocated to other institutional priorities.

Summary

The CAUSE project at Ivy University provides a good example of the challenges to be overcome in the establishment of a center for instructional development in a university in which staff are already heavily burdened with large numbers of students and with professional research responsibilities and obligations. Although the commitment of the Center staff to the CIDE has been obvious, the institution apparently has been unwilling or unable to commit the resources necessary to make the Center a real success. What has been accomplished has been done so through the dedication of faculty and staff in spite of the constraints imposed by the University. The low profile approach seems to have worked well in introducing a fairly large number of very busy faculty to the concept of instructional development without causing alienation. Given the constraints imposed on the Center staff (e.g., the allocation of only 25% release time to its director) and the faculty (e.g., heavy teaching loads and a very strong emphasis on the almost universal priority of research) it is difficult to imagine how anything but a low-profile approach would have been possible. In the opinion of this writer, the project could have come much closer to reaching the project director's ultimate goal of institutionalizing a systematic approach to the design of instruction if the project director would have been given a much greater amount of release time, and if individual faculty would likewise have been given greater support in terms of released responsibilities and encouragement to develop high quality instructional materials.

Continuation of the Center in its present configuration will probably continue to engender more positive attitudes toward an increased awareness of instructional development. However, it doesn't appear that the CIDE will achieve its ultimate goals without some important changes.

REDESIGN OF ENTRY-LEVEL COURSES IN BIOLOGY, CHEMISTRY, MATH, AND PHYSICS AND DEVELOPMENT OF THE ALTERNATE PATHWAYS TO LEARNING CENTER

Site Visitors: Albert Beilby
Jane G. Cashell
John D. Eggert
James J. Gallagher

Primary Author: Jane G. Cashell

Preface

The most noticeable characteristics of Saints University frequently cause the institution to be stereotyped in a number of ways. It is a Catholic university located in the South and serves a primarily black American student body. Those who are a little more familiar with Saints pigeonhole it another way, as a 'model minority institution'.

The science faculty members at Saints have worked long and hard to improve achievement and to reduce attrition in the entry-level course sequences. They are very dedicated to their students, and improvement of teaching is encouraged at Saints as an appropriate faculty activity.

The reader is strongly encouraged to pay close attention to the processes and outcomes of the CAUSE project at Saints. The project is well worth studying because of the care and thoughtfulness that went into it. The results should not be dismissed because Saints is a 'model minority institution'. Nor are the results any less important because Saints is located in the South. Suspend stereotypes and read carefully.

The name of the university, its location, and the names of faculty members, administrators, students and alumni have been changed to fictional names. This was done to make this case study conform to the format of the other case studies. The faculty members at Saints who participated in this study actually preferred that real names be used. Articles from the weekly campus newsletter, *This Week*, have been retyped using the fictitious names. The substance of the articles remains the same. No real names have been used except to identify Mother Katherine Drexel, the Sisters of the Blessed Sacrament, and the Kenan Foundation.

Introduction

This report describes the CAUSE project at Saints University, a small black institution in West Rivers. It is based on four visits over the period of a year, March 1979 to February, 1980. The CAUSE project is a three year project to redesign entry-level courses in biology, chemistry, math, and physics so as to reduce attrition and improve the performance of science majors. A science and math learning center was created as part of the project in order to add alternate pathways for helping students to attain predetermined objectives in the redesigned courses. The project began in fall, 1977 with a $236,800 grant from NSF and a commitment of $119,077 from Saints (see Figure 10).

Project Staff

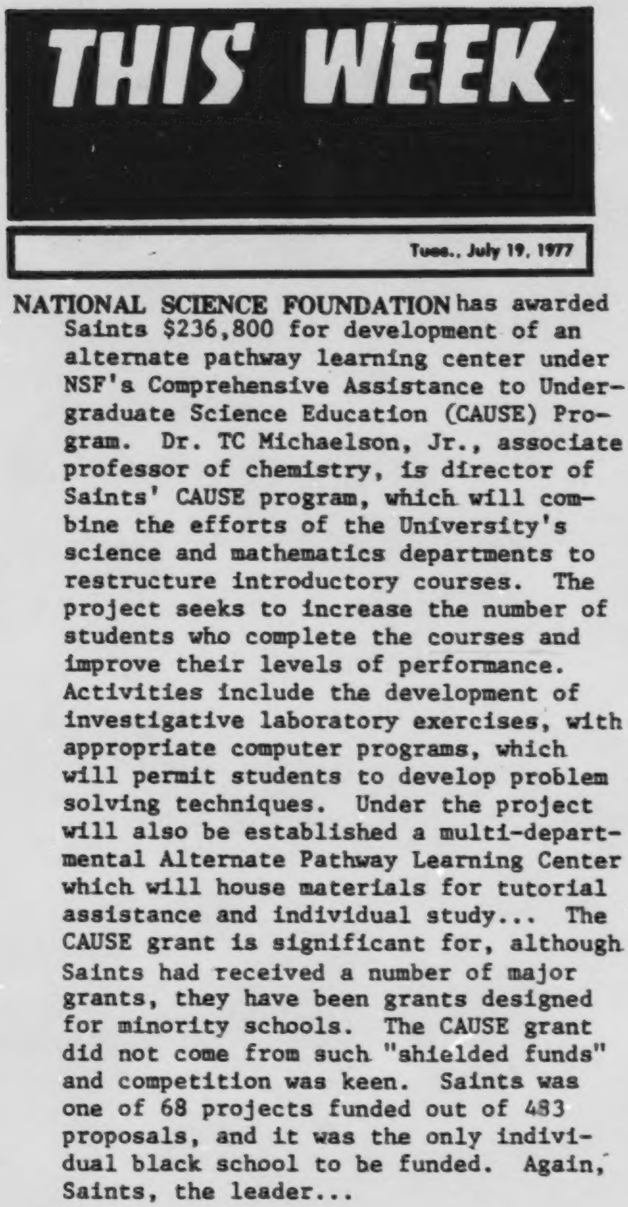
The project staff includes faculty members from all four departments, but all have not received CAUSE-funded release time. Those who have participated in the project and with whom the site visitors met are:

Biology
- Sr. Eileen Ann Heelan
- Elizabeth Mead

Chemistry
- TC Michaelson, Jr., Project Director
- Sr. Dorothy Mott
- Kathleen McVey

Math
- H. David Grimshaw
- Nelson J. Smith (Jim)

Physics
- Gerald Matthews



THIS WEEK

Tues., July 19, 1977

NATIONAL SCIENCE FOUNDATION has awarded Saints $236,800 for development of an alternate pathway learning center under NSF's Comprehensive Assistance to Undergraduate Science Education (CAUSE) Program. Dr. TC Michaelson, Jr., associate professor of chemistry, is director of Saints' CAUSE program, which will combine the efforts of the University's science and mathematics departments to restructure introductory courses. The project seeks to increase the number of students who complete the courses and improve their levels of performance. Activities include the development of investigative laboratory exercises, with appropriate computer programs, which will permit students to develop problem solving techniques. Under the project will also be established a multi-departmental Alternate Pathway Learning Center which will house materials for tutorial assistance and individual study... The CAUSE grant is significant for, although Saints had received a number of major grants, they have been grants designed for minority schools. The CAUSE grant did not come from such "shielded funds" and competition was keen. Saints was one of 68 projects funded out of 483 proposals, and it was the only individual black school to be funded. Again, Saints, the leader...

Figure 10. This Week, July 19, 1977.

The other faculty members in the four departments were involved in discussing and approving the changes in the entry-level courses though they were not part of the project staff. In addition, many of these people have been drawn directly into CAUSE project activities in some way. Among the other faculty members and administrators we interviewed are:

Sr. Maureen Brooks, University Dean
Sr. Margaret Ellen Tuttle, Dean, College of Arts and Sciences
Leo Shafer, Director of the library
Albert Nolan, visiting scholar

Biology

- Dianne Bier
- Nicholas Stone

Chemistry

- Betty Waters
- Sr. Gail Murray Stone
- Rev. Justin Ford
- James Compeau
- Fredricka Michaels
- Robert McDonald

Math

- Lyle Green
- Sr. Lucy Fleming
- Mark Foote

Physics

- Paul Kraft
- Roland Maloff
- Christina Hoyt
- Shirley Klipp
- Scott Nettles

Site Visitors

Site visitors interviewed, observed classes and labs and reviewed instructional materials and project documents to collect the data for this report. The visitors and the dates of their visits are as follows:

March 7-8, 1979; October 18-19, 1979; February 28-29, 1980

Jane G. Cashell and James J. Gallagher

April 19-20, 1979; February 28-29, 1980
Al Beilby

March 7-8, 1979
John D. Eggert

Saints University's CAUSE Project

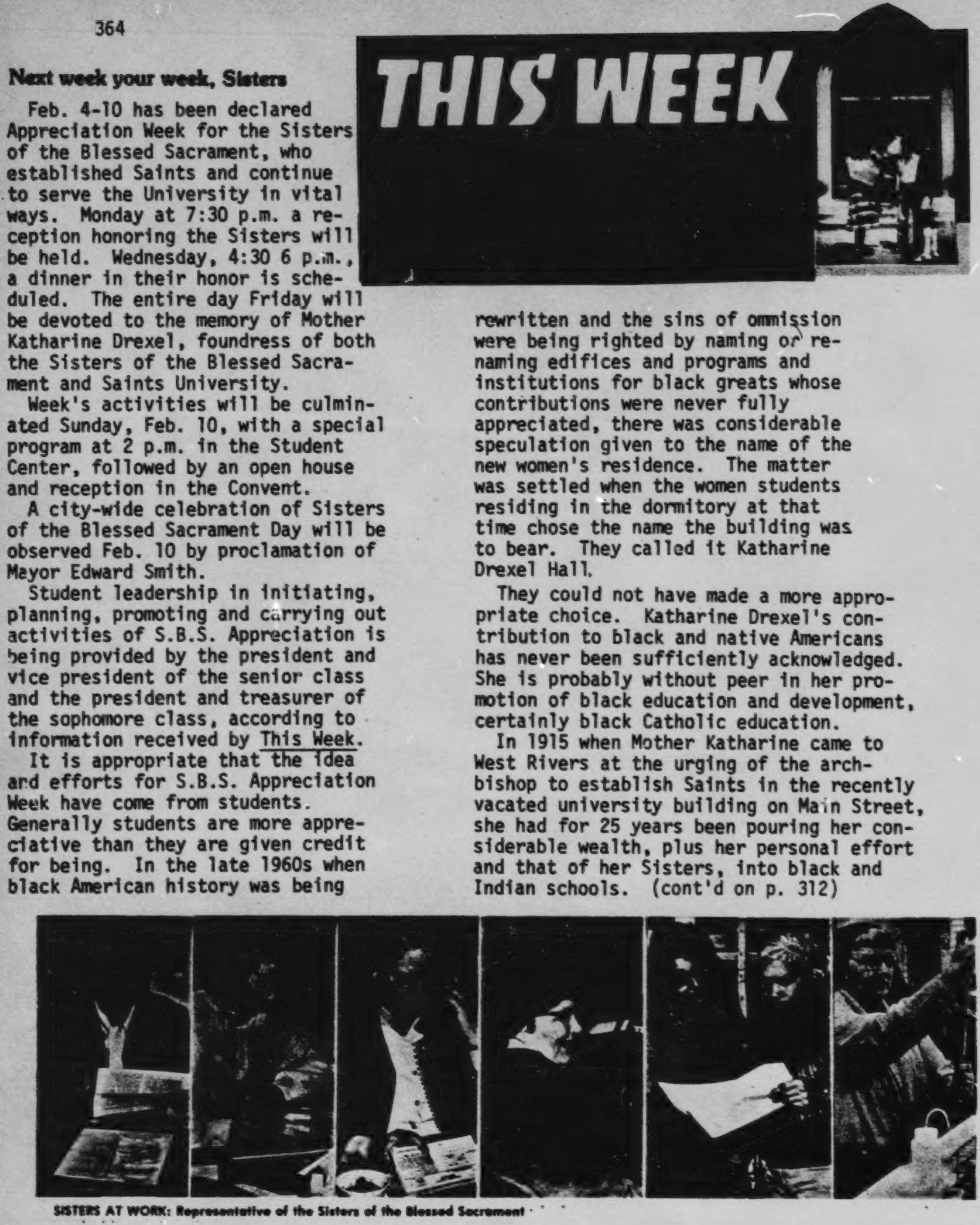
Background on Saints

Saints University was founded by Katherine Drexel and the Sisters of the Blessed Sacrament in 1915 as a high school. A normal school program was added in 1917 and by 1925 an arts and science four-year program existed. In 1927 the School of Pharmacy was started and graduate courses were offered by 1932. During the early years the Order provided all the financial support for students and institution and much of the administrative and teaching staff (see Figure 11).

Saints' mission is "as a Catholic university serving a predominantly black student body". According to the faculty and staff, the goals of the institution include realization of the full potential of each individual student through thorough and complete academic support. The commitment is to instill in students a responsibility "to create a more just and humane society".

Today Saints has about 1900 students with over one-third enrolled in natural and health sciences. In recent years student interest in professional degrees has increased the number of students majoring in premedicine, pre-pharmacy, pre-dentistry, and medical technology.

The science departments point with pride to some of the accomplishments of their recent graduates (see Figure 12). The following statistics



THIS WEEK

Next week your week, Sisters

Feb. 4-10 has been declared Appreciation Week for the Sisters of the Blessed Sacrament, who established Saints and continue to serve the University in vital ways. Monday at 7:30 p.m. a reception honoring the Sisters will be held. Wednesday, 4:30 6 p.m., a dinner in their honor is scheduled. The entire day Friday will be devoted to the memory of Mother Katharine Drexel, foundress of both the Sisters of the Blessed Sacrament and Saints University.

Week's activities will be culminated Sunday, Feb. 10, with a special program at 2 p.m. in the Student Center, followed by an open house and reception in the Convent.

A city-wide celebration of Sisters of the Blessed Sacrament Day will be observed Feb. 10 by proclamation of Mayor Edward Smith.

Student leadership in initiating, planning, promoting and carrying out activities of S.B.S. Appreciation is being provided by the president and vice president of the senior class and the president and treasurer of the sophomore class, according to information received by This Week.

It is appropriate that the idea and efforts for S.B.S. Appreciation Week have come from students. Generally students are more appreciative than they are given credit for being. In the late 1960s when black American history was being rewritten and the sins of ommission were being righted by naming or renaming edifices and programs and institutions for black greats whose contributions were never fully appreciated, there was considerable speculation given to the name of the new women's residence. The matter was settled when the women students residing in the dormitory at that time chose the name the building was to bear. They called it Katharine Drexel Hall.

They could not have made a more appropriate choice. Katharine Drexel's contribution to black and native Americans has never been sufficiently acknowledged. She is probably without peer in her promotion of black education and development, certainly black Catholic education.

In 1915 when Mother Katharine came to West Rivers at the urging of the archbishop to establish Saints in the recently vacated university building on Main Street, she had for 25 years been pouring her considerable wealth, plus her personal effort and that of her Sisters, into black and Indian schools. (cont'd on p. 312)

SISTERS AT WORK: Representative of the Sisters of the Blessed Sacrament

Figure 11. This Week, January 9, 1980.

During the first 40 years of Saints existence Mother Katharine and the Sisters provided virtually the sole support in capital and operating expenses, and, to a great degree, they provided teaching and administrative personnel. Financial assistance for students--and they all required it--came not from government grants or loans or work programs. It came from the Sisters of the Blessed Sacrament.

The Sisters lost the income from the Drexel fortune when Mother Katherine died, and alumni and other private sources have had to be drawn on in support of the University. However, the Sisters of the Blessed Sacrament continue to provide substantial support, without which Saints could not operate. Since 1968 one-third of the private support--$3,692,596 of $12,234,821--the University has received has come from the S.B.S.

Today 37 Sisters are at Saints, 13 of them teaching and others serving as administrators or administrative staff. Their services are contributed. Join students next week in expressing appreciation.

Figure 11. (cont'd)

17 headed for medical school

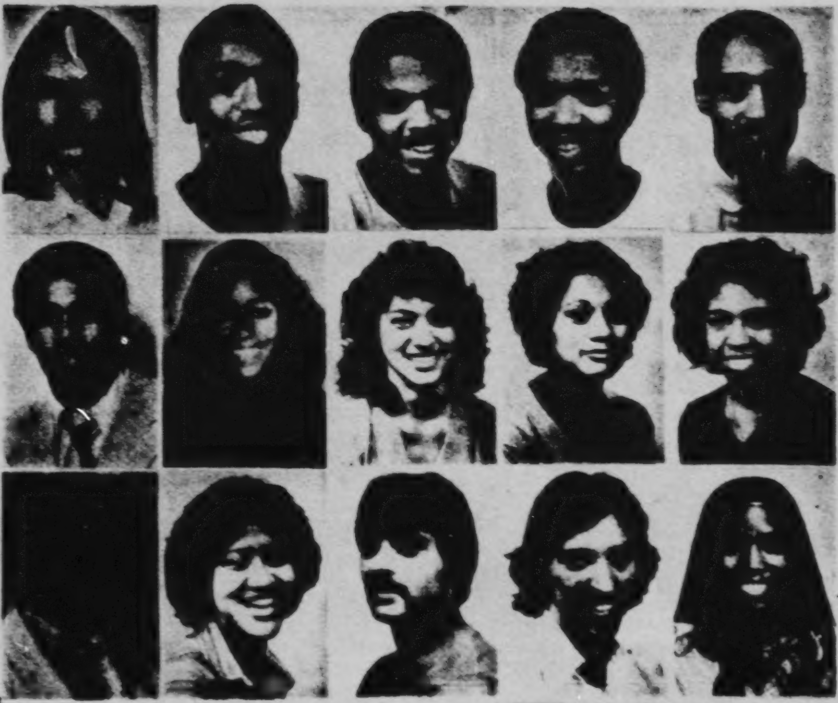
The total number of Saints graduates who will be entering medical and dental schools this fall now stands at 17--the highest number for a single year to date. The chances are very good that the number will grow to 20, which would mean 100 percent acceptance of Saints students applying for medical and dental schools this year.

Of the 17 accepted, 14 will study medicine and three will enter dental schools.

The 17 students received a total of 39 acceptances and will actually turn down offers from such medical schools as Stanford, Cornell, Temple, and the Universities of Alabama, Florida, Illinois and Texas.

The three students from this year's crop of premed students who have not been accepted are either still being considered or have been named alternates for medical school openings this fall.

With Saints' bumper crop of graduates headed for medical school this year, the University maintains its six-year record of 87 percent acceptance of medical school applications. This would go up a few points if the three remaining applicants are accepted. As it stands, acceptance rate is double the national average of all colleges and universities.



HERE THEY COME, MED SCHOOL

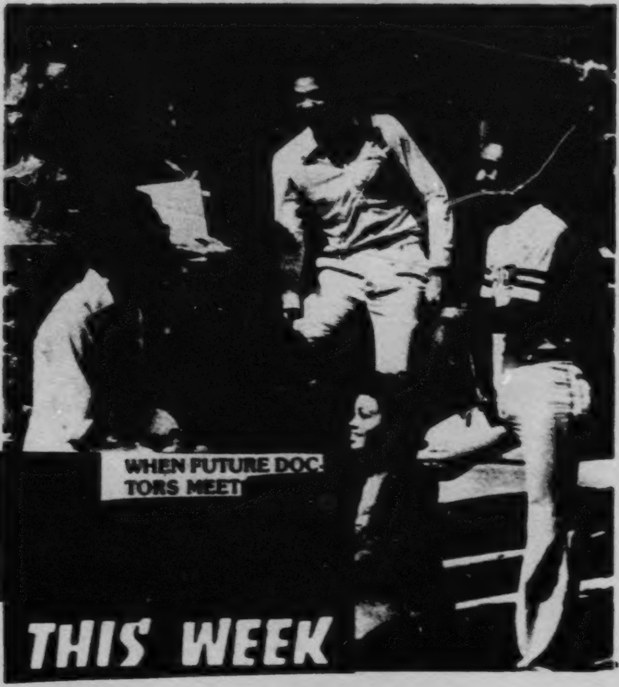


Figure 12. This Week, June 3, 1980.

are from interim report on the CAUSE grant.

1. In the past five years, 64 of the 76 SU students who applied to medical or dental school gained admittance. This acceptance rate, 84%, is more than twice the national average.
2. In 1977-78 alone, Saints placed 80 science students into graduate or health professional schools. Thirteen were accepted into graduate school, 16 into medical or dental school, ten into schools of medical technology, and 41 into pharmacy.
3. Saints' College of Pharmacy is the only such facility in the southern part of the state. More than 95% of its graduates have passed the State Board the first time they took the exam since the State began providing systematic feedback of results three years ago.

Background on the CAUSE Project

During the 1970's enrollment increased by more than 20%. At the same time the percentage of students choosing to major in natural and health sciences increased as well. Saints has a history of providing quality education to its students so this increase in enrollments and shift in majors put some pressure on the science departments.

Prior to 1976 each department had worked primarily on its own to monitor and improve instruction. For example, chemistry, math, and computer science had a MISIP grant in 1972, and in 1976 a RULE grant was used to conduct a pilot study of an investigative approach to teaching general chemistry laboratories. In 1976, Sr. Maureen Brooks asked representatives from the departments in the natural science division to examine entry-level science courses from an across-department perspective. A committee with representatives from each department began meeting every week to review science offerings.

The joint committee developed an interdisciplinary six-week program for pre-freshman science majors which is offered every summer. The focus is on laboratory exercises to promote abstract reasoning and which are based on Piaget's research and theories. The program is called Stress On Analytical Reasoning (SOAR)[1]. SOAR has attracted a great deal of attention from high school and college faculty and administrators all over the country. It also served as the first opportunity for the natural science committee to work together. As such it is the precursor to the current CAUSE project.

CAUSE Project Objectives

From this cooperative basis the same committee pursued a CAUSE grant to improve entry-level courses in biology, chemistry, math, and physics in a multi-departmental effort. According to the proposal to NSF, the Saints CAUSE project was designed to achieve the following objectives:

1. To reduce attrition from and increase level of performance by students in entry-level, science-majors courses in Biology, Chemistry, Mathematics, and Physics by undertaking the following activities in each department:
    a) detailed specification of the objectives and content of both first and second semester courses.
    b) development of an alternate pathway to supplement the traditional route in lecture courses.
    c) development of an investigative laboratory sequence to enhance students' problem-solving skills.

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[1] For further information see "Project SOAR (Stress on Analytical Reasoning)"The American Biology Teacher, V. 24, n. 3, March, 1980;

"From Concrete to Abstract Reasoning: SOAR Plots the Course" Change Magazine's 6th Report on Teaching, August, 1978;

"Teaching Critical Reading and Analytical Reasoning in Project SOAR" Journal of Reading (in press).

2. To determine the effectiveness of the activities chosen to accomplish #1 by developing and validating evaluation strategies suitable for each department.
3. To provide a multi-departmental Alternate Pathway Learning Center for non-traditional learning activities by renovating and equipping such a facility.
4. To document and disseminate information about the strategies employed and to provide mechanisms whereby institutions with similar needs may benefit from the experience gained at SU.

Project Implementation

Coordination of Curriculum Development Efforts

In order to implement the CAUSE project the CAUSE committee has met every week to plan, discuss, and review each other's work. The head of the committee is the project director, TC Michaelson. At least one committee member is specifically responsible for design of the entry-level courses in her/his respective content area. In biology, chemistry, and math two or three faculty members have been closely involved in course redesign and, although they were not all on the original CAUSE committee, they are now. These faculty members have met at least once a week as content teams to work on their courses outside of regular interdisciplinary CAUSE committee meetings. Since entry-level courses come first in all departmental course sequences, it was deemed important to keep all faculty members in each department informed of the redesign work. Frequently during the duration of the CAUSE project, departmental meetings focused on proposed changes in entry-level courses so all department members had input into the redesign of the courses.

On two occasions input was requested from all Natural Science

Division and College of Pharmacy faculty members. For the first of these sessions, the CAUSE committee invited all science faculty to attend a meeting. This gave everyone an opportunity to examine and discuss the course objectives proposed for the redesigned entry-level courses in all four disciplines. Then all science faculty were asked to rate the importance of each objective to the courses which they themselves teach (see Figure 13). The second meeting held about eighteen months later offered an opportunity for all science faculty to study and to discuss the objectives, syllabi, and exams developed for the entry-level courses. The turnout rate for these meetings has been high; a majority of all science faculty attended. This seems to indicate a strong interest in teaching. (It should be noted that wine and refreshments are offered as an additional inducement to attend the meetings which were convened on Friday afternoons. The CAUSE committee showed its political and social acumen in organizing these meetings in this way.[2]) Ratings, reviews, and comments from attending faculty indicate that they actively participate in the sessions, motivations aside.

The extent of department and division-wide faculty involvement seems to stem from real interest to learn what students are being offered in other courses and what their colleagues are teaching. The CAUSE committee purposely has worked to nurture this interest as a way to get "free" and insightful critiques from colleagues. This process is intended to make

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[2] The project director was extremely concerned that we realize that CAUSE funds were not spent to provide the refreshments.

CAUSE Workshop

Precalculus (Math 103) Content

Please indicate the importance of retaining each of the following content objectives in Precalculus at SU on the basis of relevance to courses which you teach. Use a scale of: 1 -- of little or no importance, 2 -- of moderate importance, 3 -- must be included in course.

Study Guide for Module I -- Review of Basic Algebra

Learning Goals

RANK	After studying this module you should be able to:
	1 (1.1). Know and use the terminology of set theory such as: { }-notation, equal sets, element ε, subset $\subset$, union $\cup$, intersection $\cap$, and set builder notation.
	2 (1,2). Use the terminology of and differentiate types of real numbers listed on pages 5 and 6 using the proper symbols for these types.
	3 (1.5). Define the terms on pages 20, 21 and 23 as follows: $i = \sqrt{-1}$, pure imaginary numbers, imaginary numbers, complex numbers, and conjugate.
	4 (1.5). Solve problems involving the expression, addition, subtraction, multiplication of complex numbers.
	5 (3.1). Solve problems involving the laws of exponents on pages 61, 62 and 67.
	6 (3.1) and (Supplement). Interchange the expression of numbers in scientific and decimal notation.
	7 (Supplement). Perform arithmetic operations of addition, subtraction, multiplication, division, raising to a power and taking roots using numbers in scientific notation.
	8 (3.2). Apply the laws of exponents to problems involving rational exponents.
	9 (3.3). Interchange algebraic expressions between exponent and radical form.
	10 (3.3). Apply the laws of radicals on pages 70 and 71 in simplifying, rationalizing and reducing the order of radical expressions.
	11 (3.4). Apply the laws of radicals in adding, subtracting, multiplying and dividing radical expressions.

COMMENTS:

Figure 13. Example of rating sheet for precalculus course objectives. These rating sheets were completed by Natural Science Division faculty.

faculty feel that they have had a part in designing the courses and to commit them to supporting the new content outlines for the courses.

An Instructional Improvement Process

Within the CAUSE committee, interactions have focused on several major activities designed to improve performance and reduce attrition from entry-level courses. The first is a thoughful and systematic process for course redesign. The second and related activity is the establishment of the Alternate Pathways Learning Center (APLC) to house the "alternate pathways" to learning and which are being developed as part of course redesign.

In general, the faculty members from all four disciplines have followed a similar process for redesigning the entry-level courses. It began with the development of the SOAR Project. In order to design the summer program, the committee members had to find out what was being taught and how in other science disciplines. They solved this problem quite simply by auditing each other's courses. They said they found that, in general, changes in science and science teaching methods had radically altered what topics students were covering and how they were being taught in high school and in Saints entry-level courses outside of their own area. The committee members recall that they were genuinely surprised by this and realized that they needed to adjust their own courses accordingly.

The next step was to determine exactly what content would be covered in entry-level courses. First the faculty generated topics or concepts and the related learning objectives. This process varied somewhat from department to department. In some cases the objectives were generated by all the instructors who teach beginning courses at one time or another. In other departments the CAUSE faculty members designated the objectives first and had them reviewed by other members of the department. Then the CAUSE committee worked together to scrutinize the relationships among courses. Overlaps in content and objectives from one discipline prerequisite to another discipline were sorted out. Then the objectives were presented at the meeting of the Division of Natural Science and College of Pharmacy faculty as described above.

The next stage was the gut work of developing each course. For each objective, readings in the textbook, supplemental readings, other media presentations, and exercises or problems were designated. This was done by the CAUSE faculty from each department working individually as in the case of physics or working in content teams as in the case of biology, chemistry and math. Each course was developed separately and then the accompanying laboratory sections were developed to match the classroom course. The product of these endeavors is a handbook for each course. A course overview or syllabus appears in the front. The syllabi for these courses are organized with modules which match the major topics or concepts within the course. The objectives, assignments, and study problems appear in the handbooks on a module by module basis. In some courses, grades are determined in part by successful completion of each module. In other disciplines, points are given only if the student has passed a quiz or set of problems for the module.

As the teams completed the course design process for each course, they used the new syllabus and the handbook to offer the course. Based on data gathered during one or more offerings of the course, the syllabus and the handbook were revised. The labs which accompany these courses are credit-bearing as separate courses. Lab manuals were developed using the syllabus and objectives and showing the experiments for the relevant modules.

The CAUSE committee took this approach to course redesign based in part on their own experience as teachers and in part from ideas presented at a workshop on the Personalized System of Instruction (PSI). During the first year of the grant three faculty members at Saints gave a workshop on PSI. They had all had previous experience teaching PSI courses at Saints. They include faculty members from chemistry, philosophy, and psychology.

Further refinement of the courses has been accomplished as additional activities have been added to the instructional improvement process. Saints has small classes for a university (N=40) and, therefore, entry-level science courses must be offered in multiple sections. Not all sections are taught by one instructor. When the new syllabus and handbook were used for the first time, the instructors for all sections of a given course got together to discuss the activities of each module. They noted the successful parts of the module and decided on ways to improve unsuccessful parts. In addition, they shared module quizzes and worked together to develop common exams (mid-terms and finals). Once the content of the exams was established for a course, multiple versions were developed. (Multiple versions are needed because students are given sample tests as an instructional activity to focus their studying and give them practice in test-taking.)

When the courses are offered, students have several activities in which they must participate and several optional activities. They must attend lectures and labs, and they must take quizzes to complete modules. The readings, study problems, and alternative presentations of the module available in the APLC are additional instruction. Tutoring is available on an extensive and regular basis at the APLC. Tutors' schedules and their duties are carefully coordinated so students can get the help they need. Drill sessions are also offered in some courses to help students master the content, work problems, and take quizzes. Faculty members have regular office hours and are available to students informally as well.

The CAUSE committee members were asked how their instruction had changed as a result of the project. They said that CAUSE has given them time to work together on instructional improvement, to motivate and focus each other, and to help each other overcome inertia. The faculty members described the general nature of the change in their courses as one which organizes the content to build on concrete examples to teach abstract concepts (a la Piagetian-based teaching approaches) rather than the other way around, which is how they used to teach. They said they believe the approach is more effective in teaching entry-level concepts. They cited as an example labs which require students to collect and analyze data and to test hypotheses without knowing the results "expected" from the experiment or the interpretation of the results until the lab is completed. Another change has been the addition of the "Alternate Pathways to Learning" approach to their courses. The faculty members found from writing objectives for course handbooks that the content of the textbook was not organized exactly as they wanted it to be. Written materials, study problems, quizzes and other media were added to provide students with guidance and to supplement the textbooks. Audiotapes which represent condensed versions of lectures have been developed so students are able to go through each module outside of class. Course surveys indicate that more than half of the students use the tapes and many make their own copies to use at home. Committee members also said they have learned better how to make use of instructional resources, how to revise courses, and how to approach instructional improvement. Jim Smith said it best, "I feel like I'm a trained educator now."

Instructional Improvement Subject-by-Subject

The instructional improvement process outlined above has been followed by the CAUSE faculty members in all four disciplines. The courses do not all look exactly alike due to philosophical differences among departments and differences in basic course requirements. The intent of the CAUSE project was not to make them all look the same, but rather to use a systematic process to insure a good course in the end. The differences among subjects, mostly minor, are discussed below.

Biology. Elizabeth Mead was allocated 25% release time to work on course redesign with CAUSE paying for a replacement instructor. Sr. Eileen Ann Heelan, chiarperson of Biology, became a member of the CAUSE committee, volunteering her own time. They have worked closely together to develop the syllabi and handbooks for Biology 123-124 and the accompanying lab books. Each semester of biology has ten quizzes, three exams and a final exam. Alternate media in the form of slides, tapes, filmstrips, and films are probably most plentiful in biology. The department had its own learning center before the APLC was created. In fact, it was the only department of the four to have such a center. The department generously agreed to incorporate the resources from their learning center into the APLC collection and to give up the room where the learning center was housed for another purpose, in the spirit of cooperation engendered by the CAUSE project activities.

Freshman biology has traditionally had a very high attrition rate because it is one of the first science courses students take. In order to lower the attrition rate and to insure that all four faculty members teaching the course cover the same content, the Biology Department became very involved in and committed to the CAUSE project. The department as a whole agreed to change the entry-level sequence in biology from one semester of general biology and one of zoology to a two-semester general biology sequence. This willingness to change department course offerings should be viewed as evidence of the Biology Department's desire to support the CAUSE project objectives.

Chemistry. Freshman chemistry is a two course sequence, Chemistry 101-102 with accompanying labs. Instructional resources for students are similar to those for biology and include: textbook, handbooks, lab manuals, some alternative media, try-out exams and solutions to problems. There are 15 quizzes and 5 exams each semester. The courses were redesigned by TC Michaelson, Kathleen McKay, Sr. Dorothy Mott and Robert McDonald.

TC Michaelson has focused on one special interest of his which is to give his students test-taking skills. Chemistry tests are written in item formats which students see again on other exams such as the Medical Technology Registry Exams, the state Pharmacy Boards or the entrance exams for medical and dental school. The final exam is a "prescription" final, in Michaelson's term, which means the content areas and the percentage of the test devoted to that area are pre-specified.

Students are told in advance what the prescription will be and have practice tests which are similar.

In another undertaking McKay and Michaelson conducted logical analyses of the courses by putting together the objective(s), summary of the related concepts from the textbook, quiz, review and final exam question(s) for every single module. They then graded each objective and item according to which level of Bloom's cognitive taxonomy it belonged. They examined the congruity among items to see that they were all from the same cognitive level. In a number of cases they found exam questions requiring a simpler or a more complex cognitive process than that of the concept from the textbook or the objective itself. Once or twice they discovered that they had included too much content in a module. Finally, they determined overall cognitive level of each module and checked exam questions against that.

All the CAUSE faculty members in Chemistry have participated in managing the drill sections which are part of course activities. Students must attend at least one drill a week in order to take the weekly module quiz. If they do not pass (90% correct is the mastery level) the first time they must study some more. Then they may take the quiz again during the same drill session or they may attend another drill later in the week. Students can also get some help with their work problems or get questions answered. However, students are strongly encouraged to make use of the tutoring available in the APLC as well as to attend drills. Three or four upper level chemistry students are hired as drill assistants. The Chemistry faculty members believe these students also greatly benefit from repeated exposure to basic chemistry concepts.

Sr. Dorothy Mott has added another interesting activity to chemistry drill sessions. She has developed some special problem-solving tasks to be completed for extra points. She developed her idea from Albert Nolan's notion that students need to learn a step-by-step approach to problem-solving. Students work in two-person teams on a problem which helps them review a concept from previously covered material. One student plays "solver" while the other plays "listener". The solver must work through a problem verbally by explaining it out loud and in detail to the other person. They then switch roles of "solver" and "listener" and do a second problem.

Math. The Math Department began its involvement in the CAUSE project with the intent of redesigning Math 103 (precalculus) and Math 104 (Calculus I). Precalculus includes algegra and trigonometry. Calculus I is both a terminal math course for health science majors and the first course of a three-course sequence in calculus for other majors. Since Saints is small, its enrollments do not justify offering two beginning calculus courses. Redesigning these courses so that they would serve the degree requirements of a number of different majors was complex and time-consuming. The whole Math Department became involved in delineating the curriculum because it was necessary to examine both the developmental math course and Calculus II and III. The faculty members in this department are very supportive of this effort to improve the curriculum and have been very involved in making decisions which affect the CAUSE course redesign.

Those faculty specifically involved in redesigning the Math 103-104 courses are Jim Smith, Dave Grimshaw, and Lyle Green. Math students have access to a textbook and a handbook which includes the syllabus, objectives, work problems, sample quizzes, try-out exams, and problem solutions. In addition to audiotapes and some other alternative media in the APLC, math students have access to three computer graphics terminals.

Physics. The physics entry-level sequence is two semesters, Physics 201-202, and is usually taken by sophomores and juniors. Enrollments have increased greatly in this department as the number of Saints' pre-health majors has increased. However, it is still a smaller department than the other three CAUSE departments.

Dr. Gerald Matthews is the Physics Department representative on the CAUSE committee. He has received release time to work on course redesign and CAUSE funds have been used to hire a replacement instructor. Because of the size of the Physics Department and the strain on its teaching resources he has been entirely responsible for the redesign of the two entry-level courses and accompanying labs. Since he is the only faculty member who teaches in the sequence, he has not worked in a team effort like the CAUSE faculty in the other three departments but, rather, has spent a great deal of extra, non-release time (at least most of one summer) on the project. However, his colleagues in the Physics Department are very supportive of his efforts and help out wherever possible. They have participated in extensive discussions and reviews of the syllabi for Physics 201-202 in department meetings.

Physics students now have access to the textbook, handbooks, accompanying lab book, other audiovisual materials in the APLC, and tutoring (for the first time). The handbook contains a syllabus, course objectives, sample problems worked out, and sample exams. Students in physics take six exams per semester.

Project Outcomes

The previous section of this report has discussed project implementation and has included a detailed description of a process for improving instruction. The outcome of this process is newly designed and field-tested entry-level courses and accompanying lab courses in biology, chemistry, math, and physics. Other outcomes of the CAUSE project are described below and include: establishment of the Alternate Pathways Learning Center, faculty workshops, incorporating new faculty members, evaluation activities, efforts to disseminate information about the project, and plans to continue coordination of a course's sections and overall improvement of the course.

Alternate Pathways Learning Center (APLC)

The instructional improvement process used in CAUSE course redesign assumes inclusion of other modes of instructional delivery in addition to lecture and lab. The intended alternates are educational media such as audiotapes, slides, films and computer graphics as well as tutoring. However, of the four departments only Biology had the space and the educational materials available prior to CAUSE to carry out this objective. Creation of the APLC was, therefore, identified as a major objective of the CAUSE project.

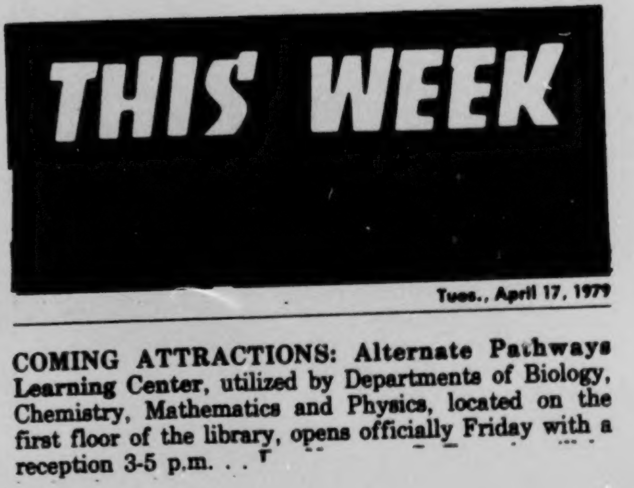
A second CAUSE-related committee was established to be responsible on an ongoing basis for the operation of the APLC. One faculty member from each department, the library director, the university dean, and the CAUSE project director serve as the members of the committee. Their first duty was to establish the APLC.

The center is physically located in the university library, rather than in one particular department. The space where the APLC is now located was filled with a number of small rooms. Extensive renovation had to be done, as part of the CAUSE project, to create one large open space center. Library-type furniture such as tables, chairs, study carrels, storage units, and free standing partitions were purchased. In addition, audio-visual and computer equipment was purchased and includes headphones, cassette tape players, filmstrip, slide, and film projectors, graphic terminals, and a printer.

The educational materials available at the APLC are not part of the university collection but remain the property of the original department. Biology, Chemistry, and Math all had some materials to transfer to the APLC. As part of the course redesign effort CAUSE money was made available to all four departments for purchasing additional educational materials related to the modules of the entry-level courses.

The APLC was completed ahead of the schedule originally predicted in the proposal (see Figures 14-16). It was first in use in January 1979, and is the home not only for alternate media but also for tutoring services in all four disciplines. It is used heavily and regularly by many students. Some students avail themselves of the media, some come for tutoring, some use the graphics terminals or the microprocessor (APPLE II), and some use several of the resources. The atmosphere is serious and business-like despite the fact that many of the tutors and the APLC staff are students. It does not appear that the center is used just as a "hang-out" or meeting place except for group tutoring and group studying.

Day to day operation of the APLC is now the responsibility of the



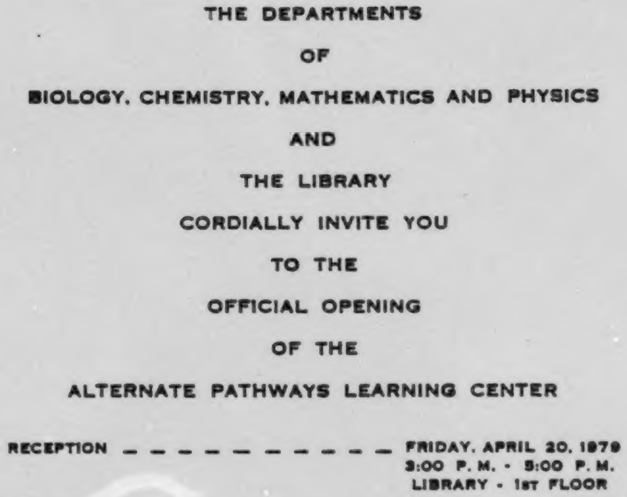
THIS WEEK

Tues., April 17, 1979

COMING ATTRACTIONS: Alternate Pathways Learning Center, utilized by Departments of Biology, Chemistry, Mathematics and Physics, located on the first floor of the library, opens officially Friday with a reception 3-5 p.m. . .

Figure 14. This Week, April 17, 1979.

Figure 15. Alternate Pathways Learning Center.



THE DEPARTMENTS

OF

BIOLOGY, CHEMISTRY, MATHEMATICS AND PHYSICS

AND

THE LIBRARY

CORDIALLY INVITE YOU

TO THE

OFFICIAL OPENING

OF THE

ALTERNATE PATHWAYS LEARNING CENTER

RECEPTION — — — — — — — — — — — FRIDAY, APRIL 20, 1979
3:00 P. M. - 5:00 P. M.
LIBRARY - 1ST FLOOR

Figure 16. Invitation to Official Opening of the Alternate Pathways Learning Center

library. Tutoring is coordinated by the departments. Rules and regulations have been drawn up by the APLC committee to insure easy cooperation between the academic departments and the library. A counter at the door has recorded the number of entrants which averages approximately 12,500 per month. A plaque on the wall gives notice to the fact that the APLC was provided by the National Science Foundation through a CAUSE grant.

Faculty Workshops

The original proposal to NSF for the Saints project requested funds to support workshops and workshop attendance as a faculty development effort. Faculty were to be paid to attend the workshops during Winterim, the month of January at Saints when no courses are offered. NSF regulations do not permit paying faculty members a consulting fee during the regular academic year. Therefore, funded workshops were moved to the summer while others were offered during the year but faculty members did not receive a fee or release time except for those already on CAUSE release time.

The workshops have been offered during the regular semester schedule and during the summer. They are apparently well received and well attended. Topics have covered: Personalized System of Instruction; Science Teaching and the Development of Reasoning; Capabilities of the Tektronix and APPLE Computers; student performance on problem-solving tasks on exams; standards with sympathy; and the two meetings described above on the objectives and syllabi for the redesign entry-level courses (see Figure 17). The workshops are offered to different groups depending on the topic (see Figure 18). Some are open to all Saints faculty and to West Rivers area high school teachers; some involve all Natural Science and Pharmacy faculty; and some are restricted to faculty closely involved in the CAUSE

JUST A LITTLE REMAINDER THAT THE FACULTY IN NATURAL SCIENCES AND PHARMACY ARE INVITED TO A WORKSHOP TO DISCUSS METHODS OF TEACHING WHICH APPEAR TO BE EFFECTIVE IN BIOLOGY 123-124, CHEMISTRY 101-102, MATHEMATICS 103-104, AND PHYSICS 201-202. It will be held on Friday, September 21st, from 2:00 to 5:00 p.m. in the Rush Room.

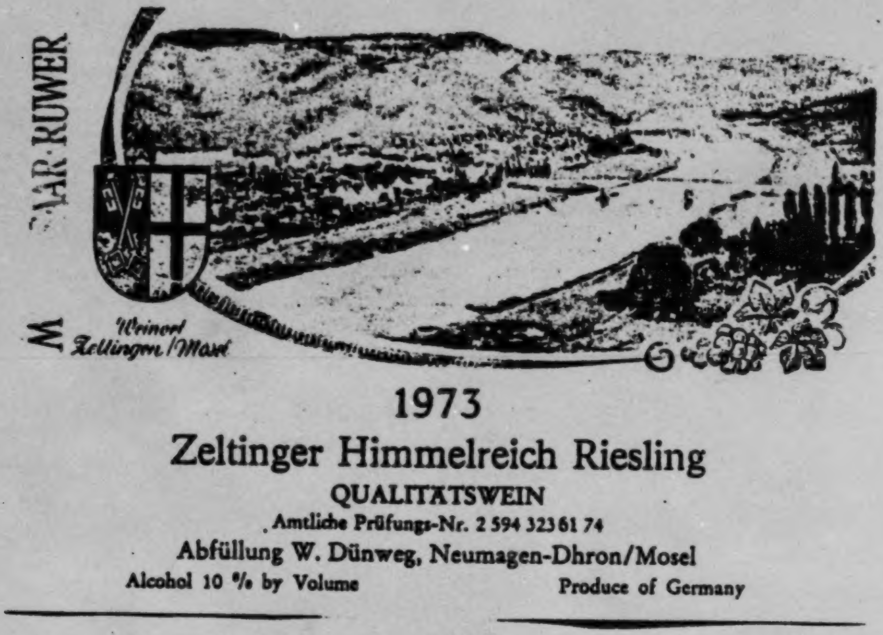

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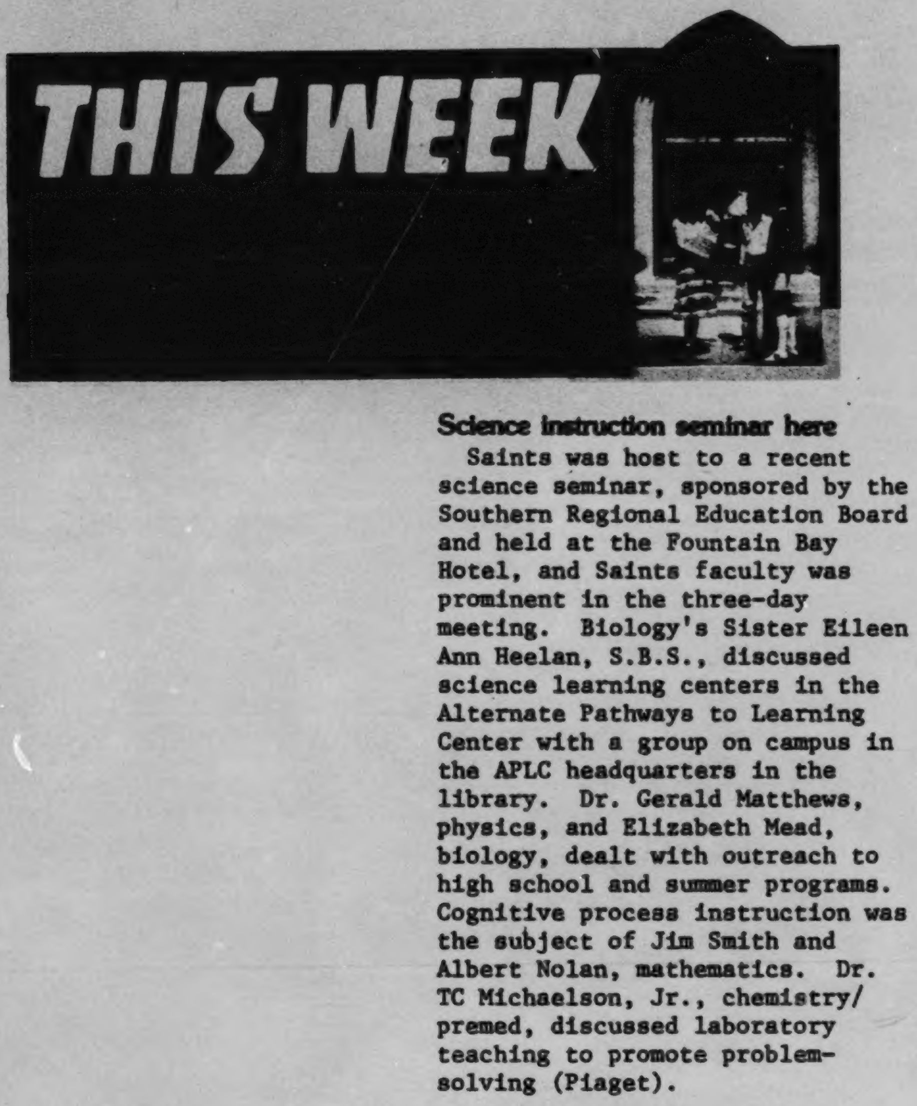
Figure 17. Invitation to Saints Faculty to Participate in a CAUSE Workshop



THIS WEEK

Science instruction seminar here

Saints was host to a recent science seminar, sponsored by the Southern Regional Education Board and held at the Fountain Bay Hotel, and Saints faculty was prominent in the three-day meeting. Biology's Sister Eileen Ann Heelan, S.B.S., discussed science learning centers in the Alternate Pathways to Learning Center with a group on campus in the APLC headquarters in the library. Dr. Gerald Matthews, physics, and Elizabeth Mead, biology, dealt with outreach to high school and summer programs. Cognitive process instruction was the subject of Jim Smith and Albert Nolan, mathematics. Dr. TC Michaelson, Jr., chemistry/premed, discussed laboratory teaching to promote problem-solving (Piaget).

Figure 18. *This Week*, December 4, 1979.

project.

New Faculty Members

One of the outcomes of course redesign at Saints has been the setting down on paper of specific guidelines for course content, objectives, exams, etc. Instructors of multiple section courses use course objectives, syllabi, and exams as the basis for discussing daily progress in their own classes. The course handbooks also serve as a basis for orienting new faculty members.

During the last two years several new faculty members have arrived in the four departments. Among them are: Sr. Dorothy Mott, Chemistry; Ms. Shirley Klipp, Physics; Dr. Dianne Bier, Biology; Mr. Scott Nettles, Physics; and Mr. Mark Foote, Math. All have been involved in teaching the entry-level courses in their departments. Each has received a careful and thorough introduction to the CAUSE project, its materials, goals, and approaches. They all appear to be knowledgeable about the project and about the redesigned courses which they now teach. Most are very supportive of the CAUSE approach to beginning courses and have found the course design and materials extremely helpful in offering a course for the first time at Saints. A few of them had not taught before and stated that they were grateful to have so much guidance and support materials in teaching for the first time. As experts in their respective fields most of them judged the course content to be appropriate and adequate. As instructors new to Saints they have observed that the teaching approaches seemed to work well with Saints students. All of the new faculty members told us that they have been involved in the CAUSE project and have felt comfortable about voicing their opinions about the project.

Evaluation Activities

A number of different activities on the Saints CAUSE project may be viewed as evaluation activities. Among them are the on-going colleague review of redesigned courses and materials, the try-out of materials in the classroom, the review of the courses by experts from outside Saints, and the comparison of pre and post CAUSE attrition and achievement test data. Each of these activities is discussed below.

Colleague review. The CAUSE committee has worked together to critique each other's work and to set up a process by which other science faculty members at Saints would scrutinize redesign efforts. The reviews of course objectives, syllabi, workbooks, and exams by the CAUSE committee, all faculty members in the four departments, and the faculty of the Division of Natural Sciences and College of Pharmacy have been described above as part of the instructional improvement process. These colleague reviews have been evaluative in nature, however, and have provided the course developers with quite a bit of feedback on both the content and the teaching approaches chosen for the entry-level courses.

In addition, as part of the instructional improvement process, the new courses have been tried out in the classroom. During the first offering of a new course the instructors from the different sections got together to discuss student reactions and to plan corrective measures for concepts which were not understood by students or learning activities which did not work. The course handbooks and lab manuals were marked with corrections and changes as they went along. Once the course was completed the books were revised based on the findings of the trials. The developers for the different disciplines found that some modules contained too much material or directions were not clear or a concept was not presented well. One team found that students were much more inclined to work the study problems if they were given space to do so under each problem right in the handbook.

Expert Review. All four departments invited faculty members from other institutions to critique their redesigned courses. These expert reviews were conducted once a year for the first two years while the courses were in the development process. The CAUSE faculty members in each department had control over the selection of their consultants. They are:

	1977-78	1978-79
Biology	Professor Biology Department North Carolina Central University, Durham	Professor Biology Department North Carolina Central University, Durham
Chemistry	Author of *Chemistry: The Central Science*, the chemistry text at Saints Professor of Chemistry University of Illinois Urbana	Author of *Intelligence Can Be Taught* & *Problem-Solving and Comprehension: A Short Course in Analytic Reasoning* Guest Lecturer, Saints
Mathematics	Associate Director, UMAP Mathematics Department University of Connecticutt, Storrs	Author of *Applied Calculus* Mathematics Department Temple University Philadelphia
Physics	Chairman, Department of Chemistry & Physics Mississippi Valley State University Itta Bena	Director, Cognitive Development Project Department of Physics University of Massachusetts Amherst

All the evaluators were positive in their reviews. The content, course format, learning activities, and materials were judged favorably. Suggestions for shifts in emphasis on some content were made. Overall the reviewers were extremely supportive of the redesign of the courses, and impressed by the faculty cooperation, the classes which they attended, and administrative support for the project.

Attrition and Achievement Test data. The objective of the CAUSE project at Saints is to improve learning in two ways: (1) by reducing attrition in beginning science courses and (2) by increasing achievement in courses which serve as the foundation for learning the material in upper level courses. To this end attrition data were gathered on a department by department basis for the entry-level courses before and after redesign. These data are shown on Table 28 just as they appeared in the interim report from the Saints CAUSE project. Attrition is defined by Saints faculty members as not passing the course with a "C" grade or better since lower grades indicate low likelihood of success as a science major. The data indicate that attrition tends to be highest in the first course of the two-semester sequence and that summer students tend to pass at a high rate. The percentage of students who pass has been computed on a yearly basis as a "through-put" figure.

Faculty members in each discipline also test their students' achievement. Testing has been a more complicated evaluation activity because of the dearth of college-level, discipline- and course-specific exams available and nationally normed. Chemistry has been able to use a general chemistry examination developed by the American Chemical Society. Biology and Math were able to use exams from the Educational Testing Service's (ETS) College-Level Examination Program (CLEP). However, neither

Table 28

Students Passing[a] Entry-Level Courses

Frequencies and Percentages

BIOLOGY COURSES	Biology 123		Biology 124		Through-put: % Pass Yearly
	Entering	Passing	Entering	Passing	
Pre-CAUSE					
Fall, 1977	182[b]	116[b] (64%)	119[c]	89 (75%)[c]	49%
Spring, 1978	68[b]	19[b] (28%)			
CAUSE					
Fall, 1978	162	81 (50%)	99	88 (88%)	54%
Spring, 1979	84	43 (51%)			

CHEMISTRY COURSES	Chemistry 101		Chemistry 102		Through-put: % Pass Yearly
	Entering[d]	Passing	Entering	Passing	
Pre-CAUSE					
1976-77	118	71 (60%)	69	53 (77%)	45%
CAUSE					
1977-78	133	91 (68%)	86	75 (87%)	56%
1978-79	156	124 (79%)	105	84 + 18 (80% + 17%)[e]	54% + 12%[e]

MATH COURSES	Mathematics 103		Mathematics 104		Through-put: % Pass Yearly[f]
	Entering	Passing	Entering	Passing	
Pre-CAUSE					
1977-78	155	56 (36%)	178	74 (42%)	42%
Summer, 1978	33	6 (18%)	43	32 (74%)	
CAUSE					
1978-79	349	148 (42%)	207	118 (57%)	45%
Summer, 1979	31	17 (55%)	44	28 (64%)	

Table 28 continued

PHYSICS COURSES	Physics 201		Physics 202		Through-put:
	Entering	Passing	Entering	Passing	% Pass Yearly
Pre-CAUSE					
Summer, 1977	25	23 (92%)	24	24 (100%)	53%
1977-78	51	30 (59%)	45	27 (60%)	
CAUSE					
Summer, 1978[g]	28	19 (68%)	21	12 (57%)	
1978-79	59	41 (69%)	63	46 (73%)	78%
Summer, 1979[h]	43	26 (60%)	28	16 (57%)	

[a] Passing is defined by Saints faculty members as a grade of "C" or better. They assume a lower grade makes it unlikely that the student will succeed in pursuing a degree in science.

[b] Biology 113

[c] Biology 114

[d] One modification of PSI at SU in General Chemistry is the option to take more than one semester to complete a course if necessary. In order to make comparisons from year to year more meaningful, numbers in this column include only those students who began the course in the indicated year, i.e., excludes students who had taken a "DC" (Deferred Credit) the previous year.

[e] The latter of these two numbers indicates the number of percentage of students who took a "DC" in Chemistry 102 and will potentially complete the course in the fall of 1979.

[f] This is the percentage of fall Mathematics 103 students who passed 104 in the spring. The percentage is depressed somewhat by the fact that some students (Medical Technology majors) are required to take 103 but not 104.

[g] Part-CAUSE only.

[h] Total CAUSE.

ETS or the professional association in physics, the American Physical Society, offer a standardized exam in physics. Physics utilized the course final exams for comparison purposes. The circumstances of testing and the resulting data are shown below discipline by discipline and are taken from the interim report of the Saints CAUSE project. Comments and observations on the data are repeated as they appeared in the report.

> Biology--In the spring of 1978 and again at the same time in 1979, a randomly-selected sample of students completing the entry-level biology courses were administered the CLEP general biology examination under similar circumstances--in laboratory for a few extra points on such short notice that no preparation was possible.

CLEP General Biology Exam

	N	$\overline{X}$	S.D.	Range	Approximate %-ile for Average
Pre-CAUSE 1977-78	39	39.0	3.91	32-46	15th
CAUSE 1978-79	29	47.6	7.62	36-64	42nd

> This data indicate outstanding success in increasing level of performance! Specific comments of note are:
>
> 1. The average in 1978-79 was higher than the highest score in 1977-78!
> 2. The percentile rank of the average has increased by 27 percentile points!
> 3. The students in 1978-79 scored close to the national average on a standardized exam for which they had no time to study and only minimal incentive to do well!!! This type of performance is phenomenal when viewed considering the entering SAT/ACT scores at Saints--an average of 752 and 14, respectively, in 1978 and an average of 728 and 13, respectively, in 1977.

> Chemistry--For a number of years, students completing Chemistry 101 have taken an examination whose content and format is very strictly specified (by the entire department). In addition, students completing Chemistry 102 have been required to take various versions of the American Chemical Society's Cooperative Examination in General Chemistry as a final since 1974. This makes comparison of performance from year to year in the two courses relatively reliable. In making such comparisons, however, it should be remembered that one of the features of the modified PSI courses at Saints is the opportunity for students to repeat the final (another version--not the exact same test). It is not yet pos-

sible to complete the analysis of performance for 1978-79 because of the group of students who will be completing the course in the fall of 1979 after taking a "DC" (Deferred Credit) during the spring semester.

	Chemistry 101			Chemistry 102			
	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.	%-ile of Mean
Pre-CAUSE 1976-77	76	129	26	58	141	37	51st
CAUSE							
1977-78	111	127	29	84	143	40	52nd
1978-79	135	137	26	87*	148*	29*	56th*

*These statistics include only the students who have already received a grade in Chemistry 102 for the Spring. They are subject to change when the students who took a "DC" at that time complete the course.

The data above indicate that the average performance level (including repeats) for students completing the first semester of the General Chemistry sequence has risen slightly as a result of CAUSE. In addition, the data indicate that the average performance of students completing the General Chemistry sequence has been slightly above the national average on the ACS General Chemistry Examination in both 1976-77 and 1977-78. Further, the interim statistic for performance in 1978-79, the 56th percentile, suggests that the final percentile mean will be above for this year also. At the very least, the latter indicates that the dramatic increase in the number of students completing the General Chemistry sequence since the CAUSE project was initiated did not occur as a result of decreased level of performance.

Math--The College Level Equivalency Examinations from the Educational Testing Service were administered at Saints over the last three years. Two different exams were used: college algebra-trigonometry and calculus with elementary functions.

	Precalculus			Calculus		
	College Algebra-Trigonometry Exam			Calculus with Elementary Functions Exam		
	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.
Pre-CAUSE 1978	29	32.5	4.01	3	39.3	6.34
CAUSE 1979	86	38.2	7.09	---	---	---
1980	126	37.2	6.26	107	38.0	4.29

Physics--Physics has developed specifications for finals for both Physics 201 and 202 and has collected performance data on finals for the past two years. These data, as presented below, will be used in future years to monitor performance in the Physics sequence.

	Physics 201			Physics 202		
	N	$\bar{X}$	S.D.	N	$\bar{X}$	S.D.
Pre-CAUSE						
1977-78	50	61.8	14.3	44	50.9	13.4
CAUSE (201)						
Summer 1978	28	71.2	15.6	20	73.0	27.2
1978-79	60	62.4	15.4	63	62.8	18.3
CAUSE						
Summer 1979	46	62.4	14.3	27	64.0	19.7

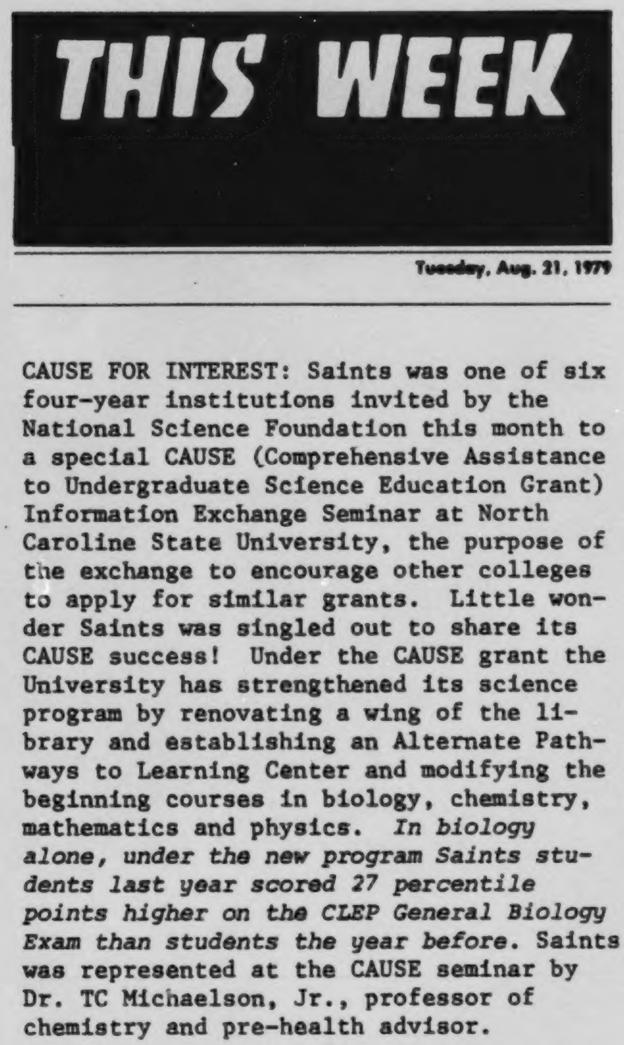
Statistics for the summer sessions are included merely to indicate that Physics 201 and 202 materials have been developed, field-tested, and refined. The small number of enrollees and the general hectic pace of summer school tends to give less reliable results than that collected from academic year courses. Therefore, no attempt was made to draw conclusions concerning the effectiveness of materials developed under CAUSE for Physics. Although it is still much too early to reach a definite decision as to the degree to which Physics has been able to increase performance in entry-level courses, the fact that the mean on finals in Physics 202 increased from 50.9 in 1977-78 (before use of CAUSE materials in 201) to 62.8 in 1978-79 is very encouraging.

Dissemination of CAUSE Project Strategies and Outcomes

The fourth objective of Saints' CAUSE project is to disseminate information about the project. This is an objective chosen as important by the project director. It is not one required by NSF's guidelines for CAUSE projects. The project director has chosen to emphasize dissemination for two major reasons. One is that other institutions that serve students with similar needs may be interested in trying out some of the ideas, processes, and materials already developed at Saints. The second reason is to have the work of CAUSE faculty members recognized both at

Saints and among colleagues in education and in the sciences around the country. Although dissemination is an important activity to the CAUSE faculty, it is not an activity which has consumed project resources of either faculty time or project funds to any great extent. Dissemination may be viewed as a natural spin-off of the CAUSE instructional improvement efforts. The project director and other CAUSE faculty members have been involved for some time in responding to requests about other instructional projects at Saints such as the SOAR project mentioned earlier. Some of the dissemination activities about the CAUSE project are listed below.

1. Mathematics Supplement prepared by Nelson J. Smith for the workshop and materials in Science Teaching and the Development of Reasoning published by the Regents of the University of California. This workshop was offered by the CAUSE faculty members for the rest of the Saints faculty and West River area teachers.
2. K. McKay, R. McDonald and TC Michaelson, Jr. "A Piagetian-Based General Chemistry Laboratory Program for Science Majors." Journal of Chemistry Education, in press.
3. TC Michaelson, Jr., K. McKay, and A. Nolan. "Cognitive Skills Oriented PSI in General Chemistry." Journal of Developmental & Remedial Education, Winter 1979.
4. E. Mead. A presentation on "Multi-Pathway Learning" for the National Science Teachers Association, Atlanta, GA, March, 1979.
5. TC Michaelson, Jr., A presentation "Summary Report for CAUSE Grant SER77-06227" for the CAUSE Information Dissemination Seminar, North Carolina State University, August, 1979. (See Figure 19).
6. L. D. Green, H. D. Grimshaw, & N. J. Smith, Jr., A presentation "Saints University's Entry-Level Mathematics Program" for the American Mathematics Association of Two-Year Colleges national convention in San Diego, October, 1979.
7. E. A. Heelan. A presentation "Alternative Pathways for Learning in a Multidisciplinary Learning Center" for the eleventh annual conference of the International Congress for Individualized Instruction, Athens, GA, November, 1979.
8. TC Michaelson, Jr. A workshop "Standards with Sympathy. Overcoming Student Deficiencies in the Sciences" for Networks, in Washington, D.C., December, 1979.



THIS WEEK

Tuesday, Aug. 21, 1979

CAUSE FOR INTEREST: Saints was one of six four-year institutions invited by the National Science Foundation this month to a special CAUSE (Comprehensive Assistance to Undergraduate Science Education Grant) Information Exchange Seminar at North Caroline State University, the purpose of the exchange to encourage other colleges to apply for similar grants. Little wonder Saints was singled out to share its CAUSE success! Under the CAUSE grant the University has strengthened its science program by renovating a wing of the library and establishing an Alternate Pathways to Learning Center and modifying the beginning courses in biology, chemistry, mathematics and physics. *In biology alone, under the new program Saints students last year scored 27 percentile points higher on the CLEP General Biology Exam than students the year before*. Saints was represented at the CAUSE seminar by Dr. TC Michaelson, Jr., professor of chemistry and pre-health advisor.

Figure 19. This Week, August 21, 1979.

In addition an article appeared in The Forum for Liberal Education, in February, 1980, about the Saints CAUSE project (see Figure 20). TC Michaelson has received a number of requests for more information about the project from readers of this article.

Continuation of CAUSE Project Activities After CAUSE

This CAUSE project funded, as its major focus, the development of the APLC and of new syllabi and materials for entry-level courses. These changes are now installed. Maintenance of them will be minimal in terms of costs to Saints. However, it is important to keep the purpose and the spirit of the project on-going. To that end the person or team in each depertment responsible for the CAUSE courses has prepared a plan for continuation. Each of the four plans is similar in its areas of concern. First, plans have been established for orienting and familiarizing new faculty members with the objectives, handbook, exams and other course materials. The second area is regular updating of the courses; students' reactions to the course will be gathered in a questionnaire designed at Saints to be used in all four departments. These data will be disseminated to all faculty members in the department. Once a year they will meet and decide on revisions and changes. Then the course handbooks will be printed for the next academic year. The APLC committee will continue to control and direct that facility. One faculty member and one student from each department will be appointed to serve for a year. At the same time that faculty member will coordinate department tutoring services for the year. In addition to continuation plans, each department has also specified procedures for coordinating multiple sections of entry-level courses.

AAC journal features CAUSE

Saints' CAUSE (Comprehensive Assistance to Undergraduate Science Education) Project is featured in the February issue of *Forum of Liberal Education*, publication of the Association of American Colleges. Director of the project, aimed at increasing access to and insuring success in health and science-related careers, is Dr. TC Michaelson, professor of chemistry and pre-health advisor. Other participating faculty are Sister Eileen Ann Heelan, S.B.S., chairman, Biology Department; Elizabeth Mead, assistant professor of biology; Sister Dorothy Mott, S.B.S., chemistry laboratory assistant; Dr. H. David Grimshaw, associate professor of mathematics; Nelson J. Smith, Jr., assistant professor of mathematics; and Dr. Gerald Matthews, chairman, Department of Physics and Pre-Engineering.

The article points out Saints' strong science orientation, with one-third of all students being enrolled in health or natural science fields and 50 percent of the freshman class indicating an intent to major in one of these areas.

Figure 20. This Week, February 26, 1980.

Each area of concern in the continuation plans has been arranged to utilize a process established as part of CAUSE activities during the grant period. The intent is to avoid difficulties in keeping the courses going since these processes have been tried out and refined over a period of three years. The responsibilities are not great and apparently can be added to regular departmental duties without placing a burden on the faculty member who is assigned to do them.

Continuation costs for the APLC require providing staff, one regular library employee and student assistants, and maintaining the equipment. The project director is certain that this support will be forthcoming from the university since the administration has been so supportive of the grant and the project activities all along and since the administrative costs of the APLC are no greater than those required to provide support services for traditional courses. (See Figure 21.)

Summary

The Best and the Worst

Faculty members in the four science departments, including CAUSE faculty, were asked to describe the best aspects and the worst aspects of their CAUSE project. The best aspects can be divided into effects on departments, on teaching and on students. There is more agreement on the worst aspects.

Mentioned frequently as a best aspect is the increased interaction and coordination among departments. Interaction had to increase in order to clarify the articulation among courses--both entry-level and upper-level--in different departments. The departments have had to coordinate

THIS WEEK

MAN FROM CAUSE and the scientists: Dr. Robert Menefee, center, program manager of National Science Foundation's Comprehensive Assistance to Undergraduate Science Education (CAUSE) Program, on campus for a site visit with the University's CAUSE project,

Dr. Robert Menefee, program manager of National Science Foundation's Comprehensive Assistance to Undergraduate Science Education (CAUSE), is on campus today for a site visit with the University's CAUSE grant now in its third year. Saints made history in 1977 when it became the first predominantly black institution to receive funding under the program. The grant has brought about a great improvement in the University's entry-level courses in biology, chemistry, mathematics and physics, partly through use of the Alternate Pathways to Learning Center, which was renovated and furnished under the grant.

Figure 21. This Week, February 5, 1980.

their efforts in order to make the APLC, the tutoring services, and the course redesign process function effectively. One faculty member said that the departments have been enriched by the interaction. Another noted that better communication has been a result of having to share a common approach to the project activities.

Many comments were related to teaching. Overall the CAUSE project is viewed as having created a standardized entry-level course which relieves the instructor of the burden of some of the worst aspects of course preparation. The instructor can feel confident that a student is getting what s/he needs. Faculty members described their courses as greatly strengthened in content. The instructor can add material to the course and still stay focused on the most important material. One faculty member said he was able to try out new teaching methods and another said the pre-planned course freed him up to spend more time with students. A new faculty member described how easily she was able to teach an entry-level course and to get feedback on what she was teaching.

Many of the best aspects had to do with students. Improved student learning was the most important aspect to many faculty members. The increase in final and CLEP exam scores give evidence of higher achievement as does the drop in attrition. Students also benefit from knowing exactly what they have to do and when it is due. The practice exams and the objectives help them learn to focus their studying. Learning is enhanced by the increase in tutoring resources available in all four subjects. The APLC and the alternative media also have enhanced learning.

Several aspects were given as the "worst". A high percentage of the CAUSE committee members bemoaned the amount of time the project and the course development took. They all mentioned how much time they had to put in to make the project successful. One faculty member said they could have used more time or more people in order to spread the work around. A couple of faculty members expressed, as another worst aspect, concern over students becoming too comfortable with pre-specified requirements. They felt that they would have trouble making the transition to upper level courses where they would be completely on their own to structure their time and their work. One faculty member expressed a wish to be able to get students into the APLC more often. Several faculty members couldn't think of a worst aspect of the CAUSE project.

Recommendations to future project directors were also elicited from the Saints CAUSE faculty. The first recommendation was one agreed upon by many of the committee members. They recommended that a project director get the commitment and the cooperation of all faculty members to be involved before the project begins. As an example they cited the science faculty at another university who wanted to begin a joint project with Saints. The Saints science faculty finally quit the project because the faculty members from the other institution could not resolve the issue of commitment from their own science departments. Several of the CAUSE faculty members described giving presentations at conferences on their CAUSE project and having faculty members from other institutions ask how they (Saints) had achieved success. They always mention first the need for cooperation and commitment from all the faculty members and departments to be affected. This apparently obvious (to Saints faculty members) requirement for a project to succeed is one which stumps other institutions, according to the CAUSE faculty members.

Another recommendation is to add more release time for all faculty members involved and for the project director. Project activities will take more time than can be anticipated at the beginning.

Several recommendations had to do with teaching. The first was to build in tutoring systematically as part of regular instruction. The second was not to underestimate the tremendous value of examining an entire course or two-course sequence at one time. Specifying course objectives is an "outstanding" opportunity for the instructor. Another recommendation is to involve more than one faculty member from each department in development. It is easier to have two or more divide up the tasks and responsibilities. They also recommended spending time only on a project which will survive and have an ongoing effect on instruction.

Comments and Observations from the Site Visitors

A number of aspects of the CAUSE project at Saints are noteworthy. The procedures and the outcomes of this project can serve as examples for prospective CAUSE project directors and others interested in understanding how a CAUSE project works. The areas particularly worth noting are institutional support, project leadership, faculty interaction and cooperation, systematic approach to instructional improvement, and concern for students.

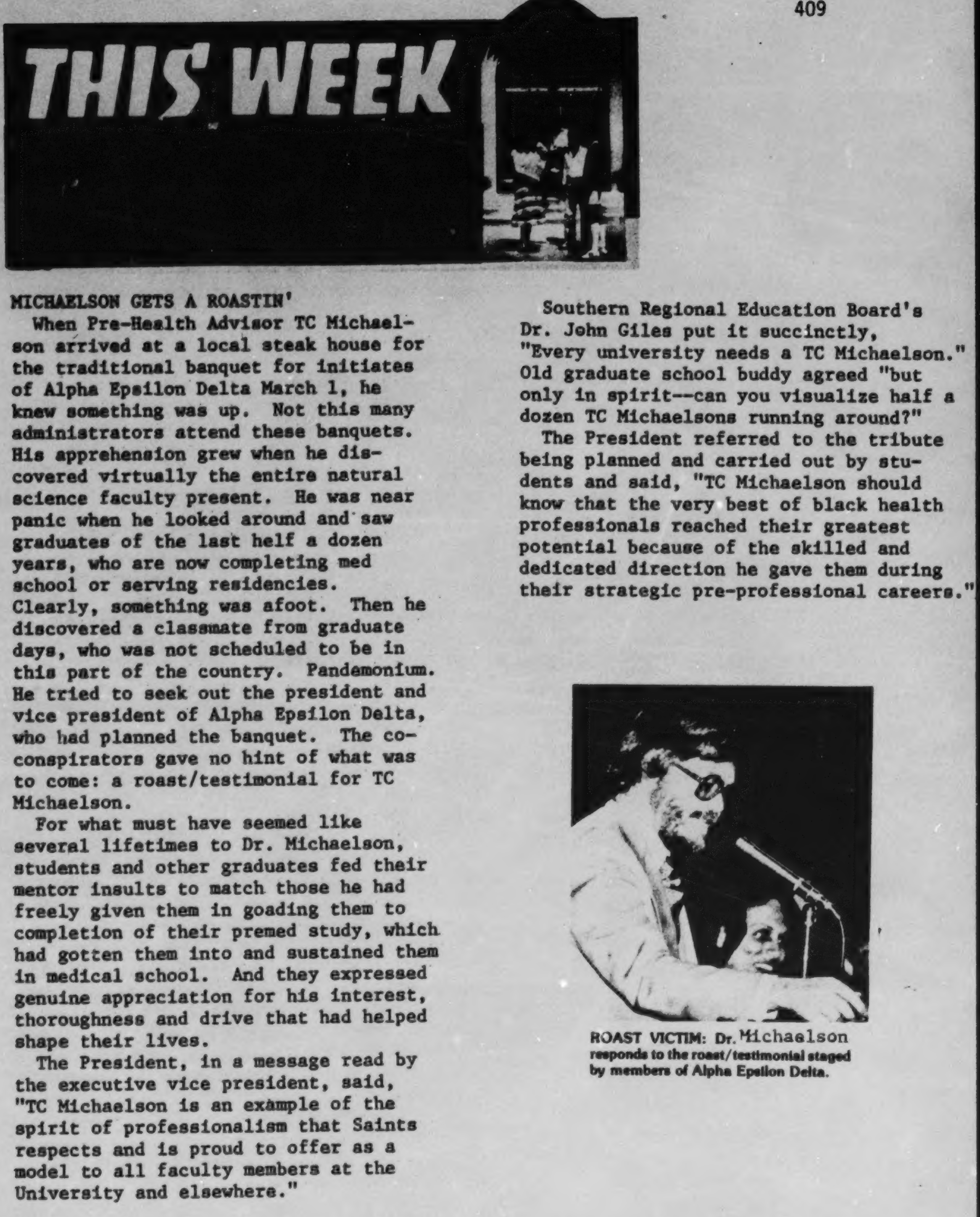
Administrators at Saints are aware and interested in CAUSE project activities. The Dean, Sister Maureen Brooks is former head of the Chemistry Department so she may be expected to be concerned about the project. However, she is also actively involved in it. Her concern over increasing science enrollments provided part of the impetus for the interdepartmental committee being formed which later became the CAUSE committee. She also serves on the committee which directs and controls the APLC. Institutional support is also evidenced by Saints' willingness to permanently commit a part of the library to a science and math learning center, the APLC. Continued support of the APLC in terms of staff and maintenance has been promised and seems extremely likely.

Additional evidence of institutional support is in the apparent need for this project. Attrition was high in beginning courses and science is important at Saints. There is a real dedication to improving the student success rate by committing resources to improving instruction. The CAUSE project is a continuation of previous improvement efforts, especially in Chemistry. As a result the improvement "bug" has bitten the Math Depart-emnt. As part of the CAUSE project the Math Department, as a whole, had to make some key curriculum decisions about what would be covered in the CAUSE courses, Math 103 and 104. These discussions were lengthy and extended over the period of a year. They have led to a commitment on the part of the Math Department to redesign all undergraduate courses. That seems to be evidence not only of the impact of this CAUSE project but also of institutional need and commitment in the form of faculty members' willingness to continue on with a project after funding ends.

The faculty members on this project have been involved and committed to a high degree. From one perspective this appears to result from exceptional project leadership. TC Michaelson provided a model for the course redesign process by redesigning the chemistry courses well in advance of project timelines. He undertook to revise the handbooks and lab manuals and to develop exams as examples of how he hoped the other departments would accomplish these tasks. He provided a structure to help the redesign process to progress in the committees with project timelines and through the use of "pesky" memos to project staff. He has a warm and friendly relationship with project staff as evidenced by the frequent trading of jokes and humorous comments (see Figure 22).

From another perspective the cooperation of the CAUSE committee may be seen as a result of dedicated and committed faculty members. Only a few of these people actually received release time but all were very involved. A number of faculty members on the course development teams worked as "volunteers" out of their own time. In addition the rest of the departments were very interested in the CAUSE project activities and spent a great deal of time in departmental meetings making decisions related to the CAUSE courses. The involvement and the cooperation of the faculty should not be seen as an established state of affairs at Saints. The committee members and other department members definitely do not all agree on everything. There are real differences in educational philosophy and perceptions of the organization of the respective disciplines. What these faculty members do share is a way to sort out their differences, compromise and reach agreement in order to restructure course curricula. They have developed a productive working relationship in order to benefit their teaching and, ultimately, their students.

The process used to redesign courses is one that was borrowed from the theories of Piaget, Keller (PSI), Bloom and others. It is not unique but it is a process that seems to have been effective at Saints. The key may be the systematic approach of checking, reviewing, and scrutinizing each change or addition to the courses. Other "homemade" processes would work equally well as long as they were as comprehensive as Saints' approach is.



THIS WEEK

MICHAELSON GETS A ROASTIN'

When Pre-Health Advisor TC Michaelson arrived at a local steak house for the traditional banquet for initiates of Alpha Epsilon Delta March 1, he knew something was up. Not this many administrators attend these banquets. His apprehension grew when he discovered virtually the entire natural science faculty present. He was near panic when he looked around and saw graduates of the last helf a dozen years, who are now completing med school or serving residencies. Clearly, something was afoot. Then he discovered a classmate from graduate days, who was not scheduled to be in this part of the country. Pandemonium. He tried to seek out the president and vice president of Alpha Epsilon Delta, who had planned the banquet. The co-conspirators gave no hint of what was to come: a roast/testimonial for TC Michaelson.

For what must have seemed like several lifetimes to Dr. Michaelson, students and other graduates fed their mentor insults to match those he had freely given them in goading them to completion of their premed study, which had gotten them into and sustained them in medical school. And they expressed genuine appreciation for his interest, thoroughness and drive that had helped shape their lives.

The President, in a message read by the executive vice president, said, "TC Michaelson is an example of the spirit of professionalism that Saints respects and is proud to offer as a model to all faculty members at the University and elsewhere."

Southern Regional Education Board's Dr. John Giles put it succinctly, "Every university needs a TC Michaelson." Old graduate school buddy agreed "but only in spirit--can you visualize half a dozen TC Michaelsons running around?"

The President referred to the tribute being planned and carried out by students and said, "TC Michaelson should know that the very best of black health professionals reached their greatest potential because of the skilled and dedicated direction he gave them during their strategic pre-professional careers."

ROAST VICTIM: Dr. Michaelson responds to the roast/testimonial staged by members of Alpha Epsilon Delta.

Figure 22. This Week, March 11, 1980.

The real basis for all the hard work on the Saints CAUSE project is the students. The faculty and administrators are committed to helping their students get the best education they can in four years. This assistance seems to be based on an ideal of attempting to make up for the deficiencies of a poor education received before coming to Saints and of demanding that Saints students be above average in intellectual achievement when they leave. The faculty enter into this work enthusiastically and it appears that they demand the same in return from their students.

A Final Note

The CAUSE project at Saints may best be viewed as a change process which affects the science faculty, in particular, a change in attitude. The CAUSE committee members have come to characterize their main tasks as instructors of entry-level courses as those of fostering interest and building basic skills in science. The purpose of instruction is to establish a solid foundation in science so students will succeed upper level science courses as pre-health science majors.

The CAUSE faculty's goal is to graduate as many well-qualified students as possible. This approach is not one shared by many science faculty at other institutions. The more traditional approach in the sciences is for entry-level courses to separate a few, most able students from those less able or less well prepared. Nurturance of ability and remediation of inadequate college preparation are considered "spoon-feeding".

The Saints CAUSE faculty, have not only encouraged an attitude of supporting learning and facilitating success for all students, though this may be seen as of prime importance. They have also added two other components to their CAUSE program. The first has been a careful analysis of the science curriculum at Saints. Objectives for entry-level courses have been compared to those for upper-level courses and to overall goals for majors. Articulation among courses in each discipline has been examined by each respective department. The CAUSE faculty has studied articulation among entry-level science courses. The science curriculum now has a logical structure, and the relationship of the content among courses is comprehensible.

The second important component of the Saints CAUSE committee's activities has been the adoption of a systematic approach to redesign of individual courses. Each course now includes pre-specified objectives, frequent assessment of student learning, rapid feedback to students on their progress, and effective remediation. Weekly assignments now involve several different learning activities such as lectures, readings, study problems, and quizzes. Multiple learning activities force the student to study a topic over and over and spend a considerable time on task. A very important variable in successful learning, according to Carroll and Rosenshine, is time on task.

In summary, the Saints CAUSE project may be viewed as having three key components. First, the faculty members have adopted the attitude that all their students have the potential to be successful in science and math. Their task is to nurture that potential. Second, the science curriculum has come to be organized in a logical fashion. The content of entry-level courses now interlocks and is articulated with upper-level courses. Third, the instructional system for courses has come to include repeated instruction, assessment, feedback, and remediation. Increasing students' time on task is known to increase student achievement.

Project Costs

This section of the report is an analysis of resources committed to the project. Particular emphasis is given to the distribution of personnel effort across various project activities.

Procedures

The cost analyst, Dr. Albert Beilby, visited the project on April 19-20, 1979 and February 28-29, 1980. Prior to the first visit, the project proposal was reviewed in order to identify project goals, functional activites, content areas and student/faculty audiences to be involved in or affected by the project.

Seven areas of function project activity were identified from the objectives, as specified in the proposal:

1. Establish objectives - in which objectives for the sciences are developed.
2. Develop tests - in which tests are developed to evaluate student gains for each of the four content areas.
3. Develop alternate pathway materials and syllabi - in which sets of instructor-prepared materials are developed to supplement weekly lectures. The syllabus summarizes, for the student, the available materials and serves as a guide through the assignment.
4. Develop problem solving labs - in which lab materials, correlated with lectures and alternate pathway materials, will be developed.
5. Establish an Alternate Pathway Learning Center (APLC) - in which a facility is established and maintained to provide a place for students to use the alternate pathway materials.

6. Disseminate and document the project - in which information about the CAUSE program is disseminated both within and outside the university.
7. Administer the project - in which the project director's general oversight time is accounted for.

These areas of activity were communicated to the project director, TC Michaelson, by letter and they were discussed with him during the initial hours of the site visit. He agreed that they were appropriate functional activities by which costs could be analyzed meaningfully.

In addition, costs are reported by the content areas--the departments of biology, chemistry, math and physics--and academic periods. The academic periods are (1) the 1977-78 academic year and summer 1978; (2) the 1978-79 academic year and summer 1979; and (3) the 1979-80 academic year. Costs are examined by these time periods in order to establish changes in effort by either department or type of activity, thereby obtaining a closer look at where project effort was directed during the life of the project.

Data were collected via interviews with project personnel, conducted during two site visits on April 19-20, 1979 and February 28-29, 1980. Project personnel were asked to estimate:

1. The number of hours they normally worked each week as a professional (treated as an average work week). Distinctions were made between summer and regular academic semesters.
2. The percent of time they devoted to CAUSE and non-CAUSE activities for each semester and summer period.
3. The breakdown, by percent, of how they distributed their time over project activities and content areas.

A distribution of effort was established for each individual. Personnel salaries plus fringe benefits were distributed across project activities in accordance with how personnel stated they spent their time. On occasion, project personnel donated time to the project.

The program had not yet terminated when this report was prepared; therefore, personnel were asked to project their relative involvement in project activities to the end of the 1979-80 academic year.

Deviations from the proposed expenses for non-personnel costs (e.g., hardware, supplies) were discussed with TC Michaelson and were judged to be minor. The magnitude of non-personnel costs remained as proposed, although occasionally the object of expenditures was adjusted. Since this analysis is an evaluation tool concerned with the purpose of expenditures rather than an audit intended to identify every expenditure to the last cent, the proposed budget was taken as the best estimate of non-personnel costs. Because these costs varied so little and adhered closely to the budget, they are reported in summary tables only.

In the summary table, personnel costs are broken out as design costs, costs relating to developmental activities, and administration costs for project management. Administrative costs include the project director's salary and some clerical salaries. This distinction will help to focus attention on the portion of effort directed at actual developmental tasks.

Results

The budget proposed for the project appears in Table 29. Tables 30-33 present personnel costs by content area. These tables are summarized in Tables 34 and 35. Table 34 identifies how personnel costs were distributed across the areas of project functional activity. Table 35 describes the distribution of costs across the content areas.

Table 29

Saints' CAUSE Project

Original Proposed Budget

Line Item	NSF	Saints	Total
Salaries, Wages and Benefits			
11. Director.	$ 6,300	$ 6,300	$ 12,600
12. Professional Staff.	33,505	73,295	106,800
15. Secretarial and Clerical.	--	9,900	9,900
16. TOTAL: Salaries and Wages.	39,805	89,495	129,300
17. Staff Benefits (when charged as direct costs)	4,777	10,739	15,516
18. TOTAL: Salaries, Wages and Benefits (16 & 17).	44,582	100,234	144,816
Other Direct Costs			
19. Consultants	5,400	--	5,400
20. Staff Travel.	900	4,000	4,900
21. Dissemination Workshops	8,000	--	8,000
22. Instructional Materials	23,200	--	23,200
23. Office Supplies	3,000	3,000	6,000
24. Non-Expendable Equipment.	48,598	--	48,598
25. Furniture, APLC	10,000	--	10,000
26. Renovation, APLC.	90,000	--	90,000
27. Computer Time	--	30,000	30,000
28. TOTAL DIRECT COST.	$233,680	$137,234	$370,914
29. INDIRECT COSTS	16,320	36,393	53,013
30. TOTAL COST OF PROJECT.	$250,000	$173,927	$423,927
31. TOTAL CONTRIBUTED BY INSTITUTION . . .		$173,927	
32. TOTAL AWARD FROM NSF	$250,000		

Table 36 aggregates the project's personnel costs and compares them to the budgeted costs relative to the source of the funds. Table 37 summarizes total project costs and shows the distinction between administrative personnel costs and design personnel costs.

Discussion

The relatively high chemistry costs (Tables 31 and 35) support earlier findings that more chemistry faculty were engaged in the project than faculty from other departments. The finding that the work in chemistry was completed before work in other areas is supported by the pattern of expenditure reported in Table 31.

The relatively high math costs (Table 35) may be due to the fact that the math faculty members involved spent more time on the project than was the case for faculty in other content areas. As discussed earlier the math department had to make decisions involving the whole lower level sequence of math courses in order to plan the curriculum for calculus and precalculus.

More personnel resources were consumed in the project than was anticipated by the budgeted figures. This is evidenced by the $94,880 in Table 36. Since the amount provided by NSF did not increase, this money is described as "excess" Saints contribution. The "excess" arises primarily from involving more personnel in the project than intended; providing higher salaries and fringe benefits than anticipated; and from devoting more time to the project than was planned. The bulk of this effort was spent in establishing objectives (particularly evident in mathematics) and in developing syllabi, materials, and tests.

Table 30

Personnel Costs - Biology

Functional Activity	1977-78 and Summer 1978	1978-79 and Summer 1979	1979-80	Total
Establish Objectives	$ 2,590	$ 1,560	$ 780	$ 4,930
Develop Tests	--	1,580	--	1,580
Alternate Pathway Materials & Syllabus	4,570	2,230	--	6,800
Problem Solving Labs	3,280	2,850	2,070	8,200
APLC	1,880	1,860	--	3,740
Dissemination/ Documentation	--	2,310	--	2,310
TOTALS	$12,320	$12,390	$2,850	$27,560

Table 31

Personnel Costs - Chemistry

Functional Activity	1977-78 and Summer 1978	1978-79 and Summer 1979	1979-80	Total
Establish Objectives	$ 5,030	$ 1,850	$ 200	$ 7,080
Develop Tests	3,170	2,120	--	5,290
Alternate Pathway Materials & Syllabus	9,190	2,430	--	11,620
Problem Solving Labs	7,900	6,700	280	14,880
APLC	3,400	5,040	--	8,440
Dissemination/ Documentation	2,810	2,440	810	6,060
TOTALS	$31,500	$20,580	$1,290	$53,370

Table 32

Personnel Costs - Math

Functional Activity	1977-78 and Summer 1978	1978-79 and Summer 1979	1979-80	Total
Establish Objectives	$ 6,290	$10,870	--	$17,160
Develop Tests	2,050	6,810	--	8,860
Alternate Pathway Materials & Syllabus	7,280	8,080	--	15,360
Problem Solving Labs	4,480	2,700	--	7,180
APLC	610	1,950	$1,890	4,450
Dissemination/ Documentation	1,150	2,400	--	3,550
TOTALS	$21,860	$32,810	$1,890	$56,560

Table 33

Personnel Costs - Physics

Functional Activity	1977-78 and Summer 1978	1978-79 and Summer 1979	1979-80	Total
Establish Objectives	$ 3,740	$ 5,060	$ 520	$ 9,320
Develop Tests	2,010	2,990	5,320	10,320
Alternate Pathway Materials & Syllabus	2,690	2,770	1,250	6,710
Problem Solving Labs	2,700	3,310	520	6,530
APLC	510	1,540	1,660	3,710
Dissemination/ Documentation	920	90	520	1,530
TOTALS	$12,570	$15,760	$9,790	$38,120

Although the budget suggests that at most 31% of the total project effort would be in personnel design activities (budget items 12, 15, and a proportionate share of 17), Table 37 presents the finding that 40% was the amount of actual effort. This figure is primarily supported by Saints, although it includes $4,000 of individually donated summer vacation time (computed at salaried rate).

The ratio of contributed cost to budgeted contribution may be viewed as an index of support. An index of 1.00 indicates compliance. The index at Saints is 1.32.

Continuation of activities initiated under the CAUSE project has been planned by project staff. Two activities are involved: operating the APLC and offering the revised entry-level courses. Continuation costs to support these activities are viewed by the project director and university administration as minimal and affordable. It is possible to estimate additional expenses acquired because of the CAUSE project.

Operating the APLC requires staff and maintenance of the facility. The APLC staff includes a library employee in charge of the Center, student desk attendants, and department tutors (students). Prior to CAUSE, three of the four departments provided tutoring on the same basis as now provided by the APLC. The biology department staffed a departmental learning center. Increase in staff will be for physics tutors and more student assistants. The project director has said that Saints views these costs as minor since virtually all students are eligible for work-study funds. Maintenance of the APLC physical facility is the responsibility of the library and also is viewed as affordable expense by Saints.

Table 34

Distribution of Total Personnel Costs By Activity Functions

Functional Activity	Costs	% of Total Personnel Costs
Establish Objectives	$ 38,490	19.7
Develop Tests	26,050	13.3
Alternate Pathway Materials & Syllabus	40,490	20.7
Problem Solving Labs	36,790	18.7
APLC	20,340	10.4
Dissemination/Documentation	13,450	6.8
Administration	20,130	10.3
TOTAL	$195,740	99.9[a]

[a] Rounding error

Table 35

Total Project Personnel Costs By Content Area

Content Area	Personnel Costs	% of Total Personnel Costs
Chemistry	$ 53,370	30.4
Physics	38,120	21.7
Biology	27,560	15.7
Math	56,560	32.2
TOTAL	$175,610	100.0
Administration Costs	20,130	
TOTAL	$195,740	

Offering the revised entry-level courses is not expected to be more expensive than was offering the entry-level courses prior to CAUSE. Faculty members who are teaching sections of the same course will have to coordinate their efforts. The CAUSE departments also plan to have faculty review a course every year in order to update it or to improve it before the course handbooks are printed for the following year. It seems that coordinating multiple sections and revising a course before the next offering will take more faculty time than before CAUSE. Saints faculty members describe these activities as easily fitting into their regular duties. If these activities do consume additional faculty time, apparently the faculty do not plan to drop any of their other responsibilities.

Table 36

Estimated and Budgeted Personnel Costs

Estimated Personnel Costs		$195,740
Contributed by NSF	$40,774	
Contributed by Xavier	60,082	
Total Budgeted Costs		100,860
"Excess" Xavier Contribution		$ 94,880

Table 37

Summary of Project Costs

Design Costs	$162,160	40.2%
Administrative Costs	33,580	8.3
Non-Personnel Costs	207,800	51.5
TOTAL	$403,540	100.0%

THE DEVELOPMENT OF INNOVATIVE APPROACHES TO LABORATORY INSTRUCTION IN PSYCHOLOGY THROUGH THE USE OF COMPUTER AND TELEVISION TECHNOLOGY

Site Visitors: David Butts
John D. Eggert
Peter Stace

Primary Author: John D. Eggert

Preface

The CAUSE project at Willows University has supported the development of approximately 125 separate instructional modules to simulate and/or extend laboratory experiences in psychology. The course materials have been prepared by individual faculty, with the assistance of CAUSE project staff. The most striking characteristic of the project has been the project directors explicit consideration of project management concerns and his effective use of junior level staff in the areas of project evaluation and computer programming/instructional development.

The most difficult challenge faced by us, the site visitors, has been the choice of focus of the case study. In order to fully portray the roles of project management, evaluation and computer soft-ware design we undoubtedly have neglected other important aspects of the project; e.g., the extensive materials and course development activities of individual faculty, the various levels of active administrative support for the project, and the use of project materials by students. The neglect of these areas should not be interpreted as a judgment of their worth, as the project would probably be considered a success from each of these important perspectives. Rather, it represents a focus made in the course of developing this study.

We enjoyed the experience of working with the project director and his staff, and feel it has taught us much about implementing a successful instructional development project. We hope to share this experience with the reader.

The names of faculty members, students, administrators, and the university and its location have been changed to fictional names to protect the privacy of those who participated in this case study. No real names have been used.

Introduction

This case study describes the CAUSE project at Willows University. The purpose of the 3-year project is to revitalize 18 laboratory courses in psychology through the development of a set of 125 laboratory modules using computer simulations of experimental work, television technology and traditional "hands-on" approaches, and through the integration of these with the current curriculum. Funds provided by NSF totaled $250,000, and those committed by the university totaled $276,558.

The Site Visits

This study has been compiled from information gathered from three 2-day site visits. The first visit, conducted in late spring of 1979 (approaching the end of the first full project year) was used to gather an overall perspective of the project and its institutional context. The team interviewed most of the faculty and staff directly involved in the project, their department chairman, dean and other administrative staff. The team also spoke with several students and observed a number of the modules then under development.

The second visit, conducted five months later, was used to obtain a more complete understanding of the instructional modules that were to be the major products of this project, and especially of the processes used to create them. Most of the time of the second visit was spent interviewing the project staff most directly involved in the instructional development process. A number of hours were also spent reviewing specific instructional modules in various stages of development.

The third visit was used to review a draft version of this report with the project director and to interview selected project staff with an emphasis on understanding the management of the project in general and of the instructional development and evaluation procedures in particular.

A functional cost analysis was also conducted at this site through two on-site interviews with project staff.

The Focus of the Case Study

The focus of this case study is on the processes of the project's implementation as opposed to its products. Furthermore, the primary focus is on those processes directly under the control of the project manager (e.g., the overall instructional development process and the evaluation process) as opposed to thos under the control of individual faculty (e.g., the development of specific courses or modules). This perspective was adopted for a number of reasons. One reason was that since we visited the project during its second year, many of the products were yet to be developed and, of those developed, many represented initial rather than practiced efforts in the instructional uses of computers and television. While many of the initial products were apparently of high quality, as a group they probably did not represent the quality of the products yet to be produced. Also, the project already had heavy external and internal evaluation components and, we felt, extensive and repeated interviewing of project faculty about their respective products would impose an unnecessary burden on them. Finally, the processes of project management, instructional design and evaluation seemed to have been heavily emphasized and explicitly considered by the project director in the design and implementation of the project. Since these activities appeared to have been planned, monitored and coordinated unusually well, they were seen as a useful focus for this investigation.

This case study is organized into six major sections. An overview of the project follows this introduction. Project implementation is discussed in the third section in terms of two important processes: project management and instructional design. The fourth section on project outcomes describes the nature of the instructional modules developed through the project and is followed by a fifth section describing the evaluation processes used in the project. The sixth and final major section describes and analyzes the project costs.

Project Description

The University Context

Willows University is the senior institution in a nine-university system. It has more graduate and professional training programs than any other in the system. The Psychology Department, in which the CAUSE project was implemented, was cited as being one of the best in the university in Willow's last self-study. The historic popularity of psychology at the university, combined with a requirement of at least one laboratory course for every undergraduate psychology major, creates quite a bit of pressure on undergraduate psychology laboratory courses and facilities. In addition, the College of Liberal Arts and Science is presently considering a requirement that a laboratory course be included in each of its 9,000 student programs. This laboratory course requirement (if enacted) will be satisfied by courses in the natural sciences, the biological sciences or in the social and behavioral sciences. The psychology majors alone have overtaxed the pre-CAUSE laboratory facilities. The potential for additional demands by non-majors (it is expected that psychology will be a popular lab course among L&S students) increases the need for expanded lab facilities. The CAUSE project is presently being viewed by university administration as a test of a low-cost approach to laboratory instruction.

The Challenge

The following is an excerpt from a paper read at the 1979 American Psychological Association meeting by the Willows University CAUSE project director. It describes his perspective on the project's rationale in terms of four major considerations: time, space, money and educational opportunities.

> Let's consider time. We have slightly more than 550 majors and only about two years' access to them. During that period, we have an obligation to provide a broad base in the fundamentals of the major areas of psychology, in experimental design, and statistics. Therefore, we have a responsibility to prepare them well for their distal educational objectives which include post-baccalaureate studies for more than 80% of our students. One critical aspect of this training involved, in our judgment, a reasonable amount of direct experience with the laboratory aspects of psychology.
>
> If the laboratories offered rich and exciting learning experiences, we expected that the most serious students would take several laboratory courses as well as conduct independent research projects and senior honors research. We anticipated that students should be able to do a far better job on these advanced research projects after they acquired the relevant skills and self-confidence in their formal, structured laboratory courses. We also felt that even the terminal BA student in psychology needed some laboratory experience to develop a full appreciation for our discipline. Therefore, we instituted several years ago a departmental requirement specifying that all majors complete at least one laboratory course in psychology.

Then, there was the problem of space. Given the anticipated onslaught of students, where were we to put them? There was no way that we could manage to run the laboratory courses in our research laboratories. And wholesale renovation of equally valuable classrooms was not a viable option. We could manage to free up one room for departmental laboratory courses in eight content areas, but not eight rooms.

There were also financial considerations. Buying enough student equipment represented a sizable one-time cost. A small shopping list would include tachistoscopes and reaction timing devices for cognitive psychology, Skinner boxes and cumulative recorders for the experimental analysis of behavior group, Crutchfield stations for social psychology, stereotaxic instruments and microscopes for psychobiology, and other hardware for sensory and perceptual psychology, developmental, and personality. But our experience had been that the real difficulty with this equipment was not the up front expenditures, but the long-term maintenance and hidden costs. Some hands-on hardware implied other costs--e.g., the Skinner boxes and stereotaxic instruments implied recurring expenses to support laboratory animals.

Finally, providing a virgin researcher with reasonable laboratory expertise in a 10-week quarter is extremely labor-intensive. We reasoned, however, that the costly, but close, supervision students could receive in hands-on laboratories could be achieved if a significant amount of the supervision could be accomplished by a computer system. If we were clever, the computer could do a great deal more.

Approach

The project director's response to these challenges was an extremely ambitious project to develop a total of 125 modules of laboratory instruction among the six major areas taught in the psychology department. Developed by departmental faculty, these modules have been integrated into the current curriculum of six laboratory courses. The modules, each representing one to six hours of instruction, primarily utilize computer and television technology. A number of them utilize more traditional "hands-on" approaches.

Physically, the project takes the form of a computer-based learning/ development lab designed out of what was previously a medium-sized lecture room which included a stage. What was the stage area is now glassed in and houses the microcomputers themselves and also serves as the office/workroom for the lab. One-half of the remaining portion of the original lecture room has been closed off into a small classroom viewing room, and the rest is used to house the terminals which are tied into the computers via cables running up to the stage. The computer system, originally planned to be a series of terminals tied into a single central computer, actually consists of twelve self-contained microcomputers, each with its own terminal and display.

Decisions relating to computer selection and procurement have been particularly challenging, usually having long-range implications. Options have included interfacing with the large university Amdahl computer; obtaining a single large minicomputer to operate a dozen student terminals; or obtaining a dozen separate microcomputers, one for each student. The university hookup was rejected primarily because of the necessarily unpredictable and often delayed response time. The single dedicated minicomputer was the option originally planned until the project director looked into individual microcomputers. "That was the best decision I ever made", said the project director. "For roughly the same cost we have equal capabilities and extraordinary redundancy... If a large single computer goes down, the whole lab will be down, maybe for days. Here, if one microcomputer fails, the student just moves over to the one next to him." When one of the microcomputers does malfunction, the project director calls the service representative, describes the problem and mails in the circuit board most likely to be in need of repair.

A separate room houses the video equipment. At times the actual programming is done in this room, other times this equipment is moved to the computer room, a laboratory or a classroom for recording purposes. The video equipment includes two black-and-white cameras synchronized through a mixer (color capabilities will be added soon). The mixer allows the producer to quickly switch from one camera to another,to dissolve, to fade one picture into another, to superimpose one frame onto another and to split the screen with input from each camera. These special effects enable the use of a variety of pedagogical techniques such as superimposing labels on previously taped examples or the simultaneous showing of an animal's behavior with a strip-chart recording the behavior. Additional equipment provides the capability of editing tapes (electronic cutting and splicing, voice-overs, etc.), with a fairly high degree of precision and efficiency. The project director believes that this equipment is particularly valuable in giving the materials a professional look and in refining previously taped instructional sequences.

The remainder of the project occurs within the offices and classrooms of individual faculty of the six areas of the Psychology Department. Each area (Developmental Psychology, Experimental Analysis of Behavior, Personality, Social Psychology, Perception and Biopsychology) is responsible for the development of a portion of the 125 modules. Responsibility for specific modules within areas is assumed by individual faculty members.

Project Implementation

This section of the case study investigates two important processes of project implementation: Project management and instructional design. During the course of our series of visits to the project, it became clear that the project director at Willow's considered these processes more explicitly than did many project directors. The proposal outlined an unusually detailed instructional design model, the project director wrote articles and gave presentations on the process of managing his project, and observations of the project revealed a greater attention to detail and coordination than is often seen on similar projects. It also became clear that what appeared in the proposal to be an unusually demanding and ambitious project was actually proceeding fairly smoothly. For these reasons, we chose to make the process of project implementation an important focus of our investigation.

Project Management

Probably the most striking characteristic of the project's management is the tension between rather rigorously described goals, objectives, timelines and procedures and the need to maintain an atmosphere of flexibility and independence among project staff. In fact, upon initially reading the project's original proposal the site visitors were somewhat skeptical of the feasibility of accomplishing all that was proposed. The development of 125 individual modules appeared to be a phenomenal task. The carefully developed timelines (see Figure 23 for an example) for each of the 125 modules seemed to portray a level of detail in project planning that is rarely achieved in similar projects. The 27-step instructional development model (Figure 24) seemed to be far too complex to be practical.

Further investigation, however, has shown that the initial skepticism was based on an erroneous assumption; i.e., that each of the detailed steps of the project plan were intended to be carried out exactly as specified. In actuality, the proposed goals and procedures were to serve as a model of expectations -- a set of benchmarks with which to gauge the

Course Relevance	Computer Simulations	Other Computer Usage	Videotapes	Traditional "Hands On"	Equipment for Traditional Modules
A. Introduction to Physiological Psychology		A1. basic concepts (CAI)	A2. action potential A3. electronically elicited attack A4. sleep EEG		
B. Intermediate Physiological Psychology	B1. behavioral biology of ingestion B2. sleep and waking		B3. septal rage		
C. Advanced Undergrad. Lab. in Physiological Psychology	C1. nature of membrance potential (from PLATO) C2. biology of learning and memory	C3. laboratory electronics (CAI)		C4. existing laboratory modules	
D. Introduction to Comparative Psychology			D1. reproductive behavior of nocturnal rodents D2. social behavior primate D3. snakes in prey capture		
E. Advanced Undergrad. Lab. in Comparative Psychology	E1. behavior genetics E2. dominance hierarchies E3. natural copulating behavior E4. open-field behavior			E5. existing laboratory modules	

Year	Quarter	Design-Development	Prototype Test-Evaluation	Prototype Revision	Field Test	Revision-Documentation	Implementation
1	Summer	A2-4 C1-3					
	Fall	B3					
	Winter		B3	B3			
	Spring		A2-4	A2-4			
2	Summer	A1 B1-2 D1-3	A1 B1-2				
	Fall			A1	A1-4		
	Winter			B1-2			
	Spring						
3	Summer	C1-4	C1-4		B1-3	A1-4	
	Fall			C1-4		B1-3	A1-4
	Winter				C1-4		B1-3
	Spring					C1-4	C1-4

Figure 23. One of Six Pages of Proposed Module Development Timelines. This one is for Biopsychology.

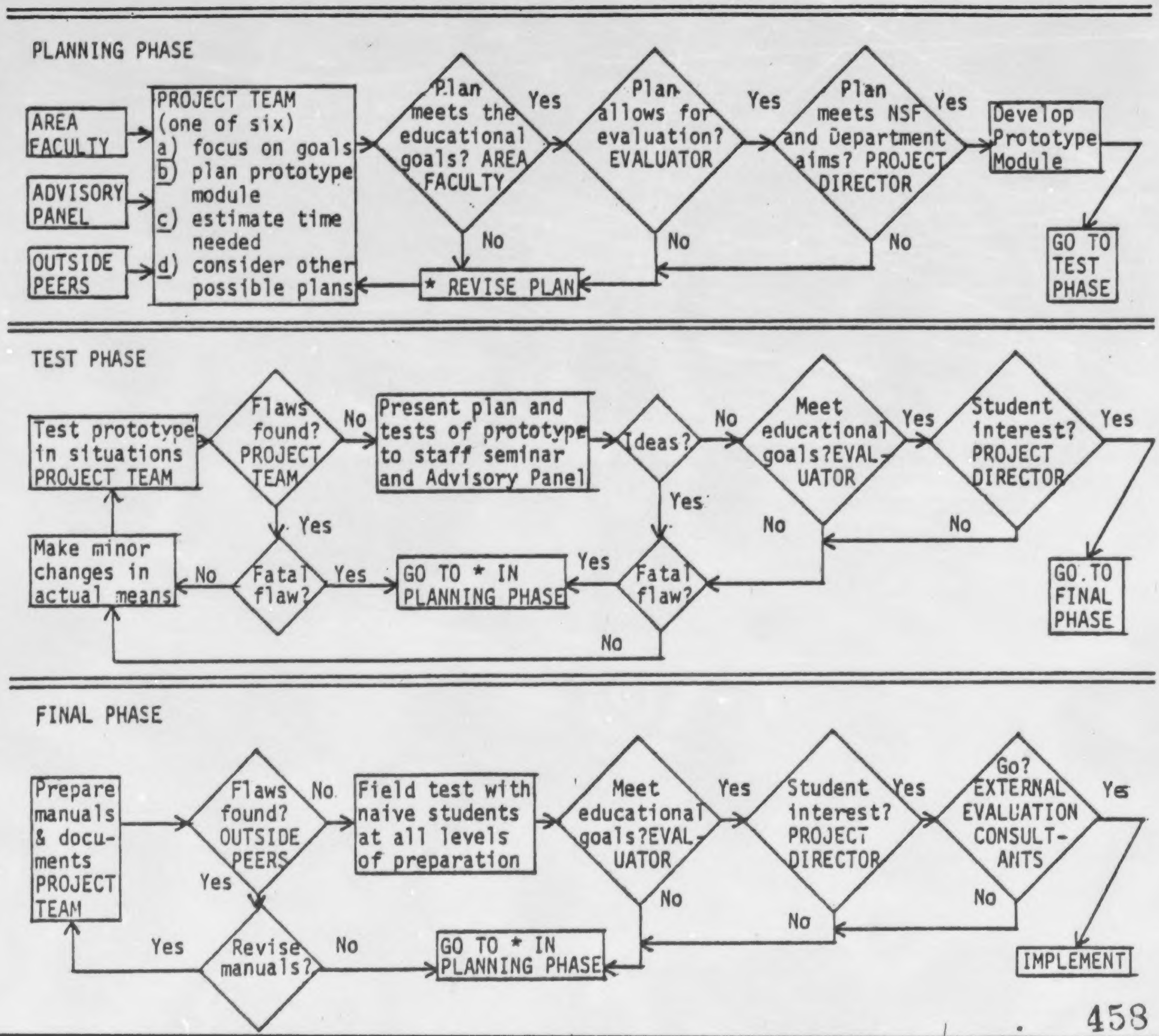

PLANNING PHASE
AREA FACULTY
ADVISORY PANEL
OUTSIDE PEERS
PROJECT TEAM (one of six)
a) focus on goals
b) plan prototype module
c) estimate time needed
d) consider other possible plans
Plan meets the educational goals? AREA FACULTY
Yes
No
Plan allows for evaluation? EVALUATOR
Yes
No
Plan meets NSF and Department aims? PROJECT DIRECTOR
Yes
No
Develop Prototype Module
GO TO TEST PHASE
* REVISE PLAN
TEST PHASE
Test prototype in situations PROJECT TEAM
Flaws found? PROJECT TEAM
No
Yes
Present plan and tests of prototype to staff seminar and Advisory Panel
Ideas?
No
Yes
Meet educational goals?EVALUATOR
Yes
No
Student interest? PROJECT DIRECTOR
Yes
No
GO TO FINAL PHASE
Make minor changes in actual means
No
Fatal flaw?
Yes
GO TO * IN PLANNING PHASE
Yes
Fatal flaw?
No
FINAL PHASE
Prepare manuals & documents PROJECT TEAM
Flaws found? OUTSIDE PEERS
No
Yes
Field test with naive students at all levels of preparation
Meet educational goals?EVALUATOR
Yes
No
Student interest? PROJECT DIRECTOR
Yes
No
Go? EXTERNAL EVALUATION CONSULTANTS
Yes
No
IMPLEMENT
Yes
Revise manuals?
No
GO TO * IN PLANNING PHASE

Figure 24. The Proposed Module Development Process

progress of the project and within which to negotiate with individual project participants regarding their respective responsibilities. The end result is to be a set of products that is well within the spirit of what was proposed but which will also reflect the individual participant's interpretations of the project's original goals and objectives.

The project director is of the opinion that a project involving a diversity of staff might be better served by a director who had some administrative clout, e.g., a department chairperson. This may be true. However, the project director has succeeded without formal power by assisting individual participants in meeting their own personal and professional objectives through participation in the project. For some, an important benefit has been summer support and/or release from specific responsibilities; for others, the possibility of having course materials reviewed and distributed by CONDUIT has been seen as an opportunity for a publication credit. For those faculty who have developed modules for their own courses (this has not always been the case), an important goal has simply been the possibility of more efficient and higher quality instruction. Some have had an intrinsic interest in computer-based instruction. Student assistants (at least the more productive ones) have seen working on the project as an opportunity for professional experience and a means of becoming more valuable on the job market. In these cases, the documented project plans and goals serve as a communication tool -- a vehicle for talking about the project, for negotiating revisions, or for refining plans and strategies.

Not all project participants have been equally committed to the project. As might be expected, some have remained unconvinced that mediated instruction would benefit their courses. Others have had other professional or personal priorities. In these cases the documented plans and procedures have been used as a basis for clarifying and airing differences, or for reminding one or two recalcitrant faculty developers of their responsibilities. This is not to imply that there has been more than the normal amount of foot-dragging among staff -- the over-achievers have seemed to counter-balance the under-achievers quite nicely. Rather, it is to illustrate the role that the explicit plans and procedures have played in this relatively complex project.

Another area related to project management is that of the development and procurement of the hardware and software supporting the instructional system. In this project, the project director has had to become cognisant of the varieties of television recording, editing and playback equipment and especially of the many options available in the rapidly advancing field of mini- and microcomputers. The project director advises investigating the characteristics of the computer's operating system, the advantages and liabilities of the programming language(s) available on a given system, the ease with which a unit can be interfaced with other equipment, the access one has to the compiler, the transportability of programs created for a given machine, the viability and the reliability of the supplier and other technical concerns. He emphasizes the importance of planning and procurement on a system-wide rather than a piecemeal basis, since the various components must be selected to complement each other.

The same is true for the procurement of video recorders, playback units, mixers, editors and the like. Even the mundane activities such as selecting and procuring connecting cables and jacks can bog a project down if they are overlooked or attempted with insufficient knowledge of potential problems. Clearly the project director's two years' previous experience on a similar NSF funded LOCI (Local Course Improvement) project has allowed him to anticipate many of these problems and circumvent them. However, he warns that even with substantial experience with the media he has sometimes been forced to make equipment procurement decisions in the absence of complete information. Some of these necessary guesses have been lucky, some have not. It is clear that for anyone attempting a project of this complexity, particularly if his/her previous experience has been limited, it is crucual that s/he becomes thoroughly educated through the published literature and especially through communications with those who have had experience on similar projects.

The Development Process

Each of the 125 modules is being developed,as proposed, by a team. However, some changes have been made in the specific procedures initially proposed. Originally, six development teams were intended; i.e., one team for each of the major areas represented in the department. Each team was to have consisted of a faculty representative to provide the content expertise and a graduate student to provide logistical help. It was intended that both faculty and students would actively participate in all aspects of development including computer programming and television production. The degree of faculty involvement in each of the modules has actually varied substantially, however, in accordance with the technical requirements of the module and the professional and personal interest of the given faculty members. The primary difference between what was originally intended and what has actually occurred is that most of the technical programming and production responsibilities have been delegated to a senior assistant and student assistants trained and monitored by the project director.

Figure 24 depicts an admittedly idealized diagram of the development process through which each module was to proceed. In practice, this plan has been followed in varying degrees. Rarely have each of the steps been formally and explicitly considered. However, most of the steps have been implicitly considered during the course of development of most of the modules. For purposes of project management and planning, the development model was simplified to six major steps: Design/Development, Prototype-Test/Evaluation, Prototype Revision, Field Test, Revision and Documentation, and Implementation. Generally, it was expected that a module would take from two to three years to develop from initial planning to final implementation.

A significant factor in the success of the development model has been that the project director had practiced the model's various stages in designing and implementing his previous LOCI grant to create a series of computer-based instructional modules in Cognitive Psychology. In addition to providing the project director with the relevant expertise, this experience also provided him with a capable technical assistant experienced in the project director's approach to instructional design. (The assistant holds a bachelor's degree in psychology.)

During the initial year of the project, the role of the director's assistant (Mr. Frank Marc) was to be primarily that of technical consultant to the faculty. The approach to module development (as initially conceived but which later proved to be unfeasible) was that the faculty person responsible for a given module was to work out the idea with his/her junior graduate assistant from the psychology department. This assistant, with technical advice from the project director and Marc, was to work out a flow chart representing how the instructional idea could be programmed for the computer. The project director spent a lot of time during the first quarter of the project training these junior graduate assistants in flow charting and basic programming techniques so that he and Marc would be required to do only a minimal amount of the low-level programming and that their technical expertise could be used for the more complex problems.

The reason this approach turned out to be relatively unfeasible was that good and efficient programming requires substantially more expertise than can be acquired on the job in a relatively short time. While students were able to create instructional modules that actually worked on the computer, they wrote programs much more slowly than an experienced programmer (e.g., a junior or senior student from computer science), and the programs they did create were often difficult to understand by other programmers, a problem if the program ever needed to be upgraded or adapted to perform on another type of machine. Furthermore, just about the time the graduate students had acquired sufficient programming skills to be efficient, it was time for them to move to another assistantship.

The project director's response to this problem has been to abandon the attempt to train the GA's as programmers, and to recruit computer science students (sometimes for pay, sometimes for credit) for this work instead. The Psychology GA's are now being trained to understand the capabilities of the computer (i.e., what the computer generally can and can't do) rather than how to actually program it to perform specific operations. This training is done by showing each new group of graduate assistants a series of instructional programs selected to exhibit the computer's capabilities. As Marc works through each program, he comments on the programming implications of various frames. For instance, a diagram of several people in a room may require less than ten minutes of programming time to create on the terminal screen if the boundaries of the room can be represented by +'s and -'s, and the people by X's and O's. However, the same diagram may require several hours to program if the walls of the room must be represented by a solid line and the people by stick figures. Because of his previous experience with the project director, Marc is able at the same time to comment on the pedagogical viability of the various approaches. For example, a computer-based module that heavily utilizes a printed text to communicate would probably be better communicated through printed sheets -- too much print on the terminal may be boring to the student and might waste computer time that could be better used for a module requiring interaction with the student.

After this general introduction, the project director has the GA's sit down at the terminals and actually work through a large variety of instructional programs. This gives the assistants a broader range of ideas of the computer's capabilities, and provides them with a feel for the program from the student's point of view -- what's fun, what's dull, what's frustrating, etc.

The GA's no longer attempt programming on their own except perhaps to gain some familiarity with the nature of the task. Rather, their major responsibility now is to serve as an intermediary between the project director and faculty person responsible for the creation of a given module, and Marc or other computer programmers. The GA (who usually has more substantive knowledge of the content area than Marc, and sometimes more knowledge of the computer's capabilities than the faculty) then works with the faculty to develop an initial module design portrayed in a way that is most useful to the programmer. In this process, the GA can help the faculty understand what might be feasible or unfeasible or provide additional ideas on the module's design. Once the approach is discussed with Marc and the project director, the GA can then work under the supervision of the faculty member in creating additional components for the module, perhaps writing or refining scripts, working out sample data, designing sample problems, etc. He can also work with the programmer to help him/her understand the nature and intent of the instruction, to know when liberties may or may not be taken to ease the programming task, etc.

Thus, the project director has gradually expanded Marc's role from that of a computer technician to that of a kind of instructional designer. Marc's increasing experience with the newer instructional technologies, the content area of psychology, and his technical expertise in computers has earned him the respect of the faculty and has allowed him to provide the project with a means of transferring lessons learned in one part of the project to modules just being started in another part. It is clear that a project of this overall complexity benefits substantially through the full-time attention of a technical assistant with Marc's personal and professional qualifications.

The project director described Marc's role in the development process. When a faculty member has an idea for a module s/he draws up a very brief module description, "a concept sheet", and submits this to Marc. Sometimes this is done in conjunction with one of the graduate assistants, sometimes not. If the problem is relatively straightforward, Marc is able to provide immediate guidance regarding its probable feasibility for use on the computer (or for some other medium used on the project such as television, or a television/computer combination). More often, Marc first works with the project director to outline a solution. If the idea proves to be technically feasible, it is developed into a fullblown plan by the faculty, often with the help of a GA. This plan includes scripts or tests when appropriate and a detailed description of the activities in which the student is to be engaged or of the phenomena that is to be simulated, etc. Marc is given authority to negotiate with faculty members on technical matters relating to programming ease, speed of execution or transportability. Pedagogical issues are dealt with primarily by the project director, sometimes with the input of the project evaluator.

More often than not these negotiations, although critical, are quite straightforward and can be resolved fairly easily. An interesting example is when a student participating in a simulation is asked to indicate quickly whether s/he observes a phenomenon on the right or left half of the screen. Almost all novice designers who face this problem instruct the student to press 'R' for right and 'L' for left, a seemingly appropriate choice. However, since it so happens that the letter 'R' is on the left hand of the keyboard and the letter 'L' is on the right side of the keyboard, students invariably become confused and are unable to respond quickly and correctly impairing the impact of the simulation. While this is a relatively trivial problem in human engineering, it makes the point that the apparently obvious pedagogical solutions need to be first strained through the requirements of the technology.

While the project director points out that transportability is not one of NSF's criteria for project selection and that local needs are the primary emphasis of this project, he feels an important secondary objective should be that the instructional modules developed in his project are usable by other institutions. Techniques he uses to encourage transportability include maintaining the versatility of a set of modules; i.e., making sure that the modules are not necessarily dependent on each other and that topic areas of interest to more than a single professor are covered. The use of complicated graphics also decreases the transportability of a module since the graphics capabilities of even similar terminals are often not identical. Thus, when graphics are proposed, considerable justification for their use is required. The project director also points out that transportability involves more than the ability to utilize the software on other equipment. Equally important is full and complete documentation for students and instructors, including clearly written manuals or guides, to insure that a module is usable by other instructors. Without such documentation it is often impossible for others to use otherwise successful modules, even other faculty within the same university using the same equipment.

A comparison of the 27-step model depicted in Figure 24 with the preceding discussion of the project's instructional development activities shows that the steps are most often not followed sequentially, such as when the input of the project evaluator is solicited at the very outset of module design. Specific roles and responsibilities are often shared by a variety of persons or, occasionally even reversed, such as when a student assistant offers advice on pedagogy or the project director locates a troublesome bug in a computer program. Also, an individual module often doesn't progress as a single entity through each of the six stages, but rather some pieces of it may be in the design stage while others are being tested with students. The degree of rigidity with which the development model is implemented varies according to the nature of the module, the subject area, and the experience and inclination of individual participants. Rarely, if ever, is it followed precisely. Rather, the model is used as a management tool. It serves as a map, detailing an idealized route complete with all interesting stopping-off-points, but also revealing and clarifying the costs and benefits of shortcuts and alternate paths. The following section describes some of the products of the Willows CAUSE project and provides additional detail on the development of the computer-based and television-based modules.

Project Outcomes

There are three major sets of outcomes of the Willows CAUSE project: The installation of the physical facilities, the establishment of a set of procedures for project management and instructional development, and the creation of a set of instructional modules. The physical facilities have already been described. The managerial and developmental procedures have also been described, although they will be further discussed in this section which focuses primarily on the computer-based and video-based instructional modules being developed through the project.

Computer-Based Modules

The project director is fairly emphatic in requesting that the computer-based modules not be referred to as computer-assisted instruction (CAI). "CAI", relates the project director, "elicits quite negative connotations among my colleagues, connotations of pages of questions and answers on a computer screen, connotations of the teaching machines of a decade or more ago---we've come a lot further than that." He also feels the acronym CAI places too much emphasis on the "instructional aspect" (i.e., the active role of the instructor or the teacher) of the medium rather than the "learning and problem solving aspect" (i.e., the active role of the student through modeling, simulations or gaming).

The computer-based modules are generally conceived of as adjuncts to the lecture-discussion, not as substitutes for it. They are intended, however, to be a direct substitute for certain laboratory experiences. The opinion of the staff seems to be that while many times the computer-based substitute is less than an ideal simulation of the laboratory experience, more often than not it offers instructional advantages over the lab that outweigh the disadvantages.

For example, many of the modules will make use of a scaled-down version of the Michigan Experimental Simulation System (MESS) and the smaller University of Louisville version (LESS). The project director has nicknamed his system MUCHLESS, because it is so small that it can be run on even a time-sharing microcomputer. (It takes only about 3.5K words for any program).

MUCHLESS, like the LESS and MESS, allows the design of the general structure of an experiment (e.g., the development of a strain of rats exhibiting certain behaviors) in such a way that the student is able to manipulate a number of the experimental parameters. For example, in the behavior genetics experiment the student may decide on the number of parents to breed, which will mate with which, and how many offspring each will have. Then, the student pushes a key on the terminal and in seconds is presented with a new generation of offspring, each identified by number and each provided with a measure of the behavior being studied. The assignment of characteristics to offspring is random, except for the influence of the parents the student selected to produce those offspring. By selectively mating pairs of the offspring, the student is able to run through a dozen generations of rats in less than half an hour, developing a strain that possesses the characteristics desired. Due to time and cost restraints, no student would ever be able to perform these breedings in a conventional course.

The MUCHLESS system is fairly easy for faculty to use in developing their own models, particularly after they have designed their first one, although it requires a thorough understanding of the recent experimental literature so that meaningful results can be designed into the program. They must decide upon an experiment that is relevant to the topic, decide how many dependent and independent variables are desired, their ranges, their effects and interactions, which parameters are to be under the control of the student, etc. S/he then writes the text explaining the experiment to the student. Some text may be put on the terminal itself but usually is more efficiently presented in separate printed materials. The faculty designer can do most of the work at the computer terminal with relatively little training, being prompted with questions like "How many dependent variables do you want?", and "What do you want to name them?" Faculty may include intuitively appealing variables which are actually irrelevant to the experiment to more closely approximate a real-world experiment.

The MUCHLESS system, then, simulates experiments through the generation of raw data for a particular experimental paradigm. The project director has also made use of another approach to the simulation of experiments -- that of using the computer to simulate the equipment found in a psychology lab. By varying the time a display is on the screen (from 20 milliseconds to as long as desired) it is possible to use the computer like a tachistoscope, a memory drum or even a slide projector. Auditory feedback is also possible if the terminal has a built-in speaker, or if an inexpensive integrated circuit chip is interposed between the computer and a tape recorder.

Developing a feel for the appropriateness of various applications of the computer has also been a gradual learning process. There have been times when the liabilities of complicated graphics, such as lack of transportability or the extensive programming time, have been outweighed by the benefits of increased efficiency of learning or the elimination of expensive laboratory equipment. There are other times when an exciting, intriguing and innovative computerized approach to a given topic has been scrapped simply because it can be done better on a ditto master. "The important criterion for using the computer", advises the project director, "is whether or not student interaction is required. If the student doesn't have to do anything, then it is probably better to use some other form of instruction."

Video-Based Modules

The television modules play a role in instruction similar to the computer-based modules; that is, to augment normal instruction and to substitute for specific laboratory experiences. Specifically, they are to provide for educational opportunities not otherwise feasible (e.g., as it is not possible to breed many generations of rats, it is not feasible to take large numbers of students into a newborn hospital nursery for testing of neonatal behavior). The development of these modules follow roughly the same procedures and encounter the same general types of challenges: learning when TV is the most appropriate medium, what its benefits and liabilities are, how to develop and produce the modules effectively and efficiently, what the pedagogical and technological "tricks of the trade" are, how the capabilities of the available equipment can be stretched to provide creative solutions to specific instructional problems, etc. As with the computer-based modules, the TV-based modules are rarely used completely on a stand-alone basis. Most often some advance preparation (either through lecture or readings) is assumed, and often some sort of instructional guide is required to aid the student viewer.

Some of the television-based modules were originally designed for the computer. For example, the computer graphics capabilities proved useful in generating a number of modules which required movement on a screen, but no student interaction. However, once the graphic routines were produced, the computer's capabilities were no longer needed and the illustrations were transferred to videotape.

The project director groups another type of uses for microcomputers and television under the broad term of "hybrid". For example, one of the instructional modules requires the student to observe a videotape of a card game played by four people. The student uses the computer to generate an individualized measuring instrument from a list of 54 general and specific non-verbal behaviors and then uses this instrument to collect data on the behavior of one of the individuals playing the card game. The student then enters the observed data into the computer which checks it against known values and provides the student with information on the accuracy of the collected data.

The Role of Evaluation

Evaluation is an integral part of the instructional development process, and at times is indistinguishable from it. Because of its importance on the project, however, the evaluation process is treated here separately.

The role of evaluation, and the project staff's perception of it, underwent an interesting evolution during the first half of the project. The original proposal included a three-day visit by a nationally recognized evaluation expert and a well-known science educator at the end of each project year. It also included a plan to make use of a local evaluation specialist who carried quite a bit of credibility in educational evaluation on the university campus. The module development plan also listed a number of evaluation checkpoints. These included a review by the area faculty, the project director, and the advisory panel during the early planning stages; reviews by major participants of prototype test results; a formal evaluation of student achievement and interest by the evaluator and project director, respectively; a peer review by colleagues from other universities; and a final field evaluation and assessment by the local evaluator, the project director and the external evaluator. This final approach was to have used quasi-experimental strategies. Also described in the proposal were time-series analyses to trace the change in GPA of majors and in elective enrollments in individual and honors courses. There were additional plans to monitor changes in the quality of students' independent research endeavors, as well as in the incidence of students choosing advanced study in fields of science.

There is some evidence that a number of project staff were suspicious of evaluation. (Not an unusual phenomenon in instructional development projects in general.) There were also a number of indications that faculty were unsure of what evaluation could do to them. Based on conversations on this topic with project staff, it appears to us that this suspicion did not arise out of either self-doubt or an unwillingness to question the quality of their own work, but seemed more due to a lack of confidence that outsiders to the department as well as to the field of psychology could have anything useful to offer them since each of the faculty members was an expert in his or her own field. This attitude seemed to prevail with respect to the external evaluators as well as to this case study of the project. The dominant view of evaluation seemed to be as something imposed from outside, with little relevance to the day-to-day necessities of the project. The project director points out that it should be expected that academic scientists do not have a thorough understanding of evaluation, just as evaluators are not expected to have a thorough understanding of biology or physics.

This rather negative perception of evaluation was dealt with by the project director and his evaluation team in an interesting fashion. Rather than trying to have the evaluation done by recognized authorities with considerable personal and professional prestige, a doctoral student in education was chosen who more or less acted as an extension of the project director himself. This selection marked what apparently is the development of a new attitude (and some new approaches) to evaluation on the project. Ms. Jo Garcia, an evaluation student, is well qualified for the task. She has completed her Ph.D. course work in evaluation, she has a B.S. in psychology and has had practical experience on a number of evaluation projects during her doctoral student career. Not included in the original proposal, she was selected by the project director to augment the efforts of the local institutional evaluator. The project director cited her low-keyed personality as well as her student status as an asset to the project. "Garcia does well in the role of evaluator because she is perceived as non-threatening." Originally, the project director accompanied Garcia on her initial visits to individual faculty. However, after an initial breaking-in period, and after her first interview with faculty on her own, the project director concluded that she did better without him present, possibly because of her perceived lack of power. Allowing the evaluator to conduct her interviews alone also freed up the project director's time for general project management and coordination.

Garcia is conscious of the impression she creates, feeling the only way she can have any impact on the quality of instruction is to first gain the confidence of the faculty. "However," she cautions, "the evaluator also has to be aggressive--she has to come to the faculty, she can't wait for the faculty to come and ask for help."

Garcia began working on the project near the beginning of the second project year. She has spent time working with individual professors establishing a basis for her evaluation activities. This initial strategy consists of four steps.

The first step is to introduce herself, and the concept of evaluation. Initial reactions are not always positive, either because of an unfamiliarity with the role of evaluation or because of a lack of time to deal with it. Garcia's response in such situations is to recognize that participating in evaluation activities can be initially troublesome but that evaluation also might help to reduce some of the faculty member's burden of instructional development activities. She sometimes asks a series of leading questions about the faculty member's development efforts, working up to an offer to help by providing information on what is going well, as well as what is not. Garcia reports that eventually most faculty are willing to cooperate, as long as they aren't overburdened with a lot of extra work.

The second step is to clarify the specific instructional objectives the faculty member hopes the module will meet. Based on the initial interview, Garcia actually takes on the task of creating these objectives. While most faculty members have already informally established instructional objectives -- "It is all in the faculty heads already", as Garcia puts it -- she feels it's a lot to expect to have GA's and faculty actually write out their objectives given all the other demands of the project. The project director, Marc, and Garcia all feel the development of objectives is crucial to both development and evaluation. Marc states, "It clarifies in the faculty member's own mind what he wants to get across." Marc says he finds creating objectives to be a very useful means for faculty to communicate with him in his developer/programmer role. The faculty are encouraged to keep records of all their notes to help develop and clarify the course objectives.

The third step is to return these objectives to the faculty, in a formal memo, for review. Included in this memo are recommendations for evaluation as well as preliminary suggestions on how the anticipated approach might be approved. Garcia and Marc work closely together on this whenever possible. Garcia has tried to keep the tenor of the memo suggestive and open-ended to insure that the faculty feel in control and can retain "ownership" of the module. Before the memo is finalized, it is submitted to the project director for review, modification and final editing. Coordination between the project director and the evaluator is easily maintained on a daily basis since the evaluator's office opens directly into the project director's office.

The fourth step of this initial work has been to revisit the faculty to review objectives, recommendations and suggestions, clarify and restate problems and issues, and to discuss the evaluation. Garcia hopes to be able to collect feedback from the students (regarding interest, clarity, problems encountered, etc.) on each module, as well as pre- and post-test data on each module. Other formal evaluation strategies have been tried or are anticipated including a quasi-experimental comparison between the lecture approach and the computer-based approach to a given module.

Garcia has found the above process, which results in a 3-5 page typewritten memo for each module, to be fairly time-consuming. While the project director and his assistants feel the process is important to both the evaluation and the development process, they acknowledge that they may not be able to be as comprehensive with every module. Garcia has emphatically recommended that "If someone has this sort of job, it's better for it to be full-time rather than one-third time." It seems reasonable, however, to expect that future attempts will go more quickly and efficiently, once the procedure becomes established.

It appears that a number of less formalized but at least as important evaluative activities also occur on the project which are monitored and encouraged by the project director and his assistants and implemented by virtually all project participants. These are the formative evaluation activities, the activities engaged in to correct and improve the individual modules while they are being developed and while changes can still easily be made.

The project director noted that although most faculty members are unfamiliar with established formative evaluation techniques, most do conduct some sort of formative evaluation activities without considering them to be evaluation. Garcia sees herself as a facilitator with respect to formative evaluation, assisting and encouraging faculty in the collection of feedback on their developing modules. Sometimes this feedback is as simple as requesting a colleague to review an idea. Other times faculty have found it useful to merely observe one or two students working their way through a draft module, watching for points that are unclear or segments that are too difficult or too boring. The students' comments themselves are often very useful. The project director and his team's experience on other modules provides another good source of formative information. Many problems are recurrent and, when identified in one faculty member's module, can be corrected in the developmental stage of another's work. For example, faculty are discouraged from trying to ad lib the text of a televised experiment--it is clear from earlier modules that it is impossible to organize and time the verbal sequences at maximal efficiency without first scripting them out. A related example is that project staff have become alert to the tendency for "first-timers" to read such a script too fast. Another common mistake made in designing computer-based instruction is to use too much text which is a lot less efficiently read on a terminal screen than on a printed page, and a lot more expensive. Project staff have learned to keep the terminal messages short, providing printed back-up material if additional verbiage is necessary.

Sometimes this sort of early input results in major changes or in the scrapping of an entire module. More often, however, it results in a series of relatively minor, often common-sense changes, the combined impact of which may result in a substantially improved module.

The project director is of the opinion that while summative feedback upon the completion of the course is useful "the problem with course feedback at the end of the quarter is that you don't get a chance to get the extensive specific details and interpretations from the students". On the other hand, the project director points out, fairly useful summative data can be acquired through the analysis of accumulated formative evaluation data. The immediate nature of the formative evaluation data is also viewed as important, in that inquiries made shortly after administration of a module are likely to be a richer source of data than the same inquiries made days or weeks later.

The formative evaluation approach the project director encourages is to collect as many kinds of formal and informal information on each module as possible. The facilitator role is important here since the evaluator helps the faculty person to do what s/he might well do anyway if s/he had the time. It is here that the roles of Garcia and Marc overlap. It is often possible, in an evaluation planning session, for Garcia to give hints on instructional problems she has encountered before. Similarly, Marc is often able to provide evaluative feedback based on the input he gets from students, GA's and other faculty as he works through the development process.

A particularly useful formative evaluation method used on the project is to pilot test an early version of a module, or a part of a module, with only five or six students. These students are then interviewed and provided with an open-ended questionnaire asking how well they could see or hear, what they thought worked well or not so well, how interesting it was, how it might be improved. A pre- and post-test is also occasionally given at this stage.

Other data collection techniques that are found useful include simply asking for a half-page of prose comments from the student, and actually observing students working through the material. One such example involved the evaluation of an activity which required students to record information on a form. The initial trial showed that the form was difficult to follow because too many responses had to be recorded on a single line. The problem is being remedied by redesigning the form. Although the solution is simple, the problem is important and would have gone overlooked without the benefit of formative evaluation.

There are other formal and informal plans for evaluation. The computer modules that are transportable are being provided to CONDUIT, the NSF-funded distribution network for instructional computer programs in science,and CONDUIT will conduct its own independent evaluation. In addition, Willows faculty will review each other's materials internally, particularly as they consider them for use in their own courses.

The external evaluators still play an important role in the project. While their original primary intent (i.e., to conduct an evaluation of the outcomes of the project as well as the processes used to achieve them) still is considered important, the project director now feels that the evaluation consultants may be more appropriately used in a consultative mode, particularly with respect to the process of evaluation. Thus, they will be asked on subsequent visits to concentrate on critiquing the evaluation activities conducted so far and providing advice on the design of summative evaluation activities. In retrospect, the project director suspects that it might have been more appropriate to bring in the external evaluation consultants early in the first year of the project, rather than waiting until the first year's end. This approach would have complemented the use of a non-threatening internal evaluator to actually identify and correct problems within individual modules.

Project Costs

This section of the report examines the costs incurred during the first five academic quarters (June 1, 1978 through August 31, 1979) of the Willows University's CAUSE project. The project is budgeted for $526,558 over a three year period. This budget figure includes both the National Science Foundation grant of $250,000 and the university's proposed contribution of $276,558.

The cost report begins with a description of the procedures used to conduct the analysis of project resources and then presents the results for each category of experience and their allocation to content areas and modes of instruction. Project costs are then examined as a whole with particular attention to the sources of funding for various aspects of the project and its future operation within the Psychology Department.

Procedure

The cost information which follows is based on data provided by the project director, the computer programmer for the project, and a member of the faculty working with the project. The first site visit occurred on October 4-5, 1979. On that occasion the cost analyst was accompanied by the science educator, and the site evaluator. The project director was thoroughly familiar with all aspects of the project and had immediate access to all budget and accounting information. He was open and candid in his discussion of the level of effort and productivity of project personnel, as was the programmer with whom the cost analyst spoke on this visit. The second site visit occurred on April 1, 1980, and allowed the analyst to reexamine the results reported from the first visit and to verify findings with a member of the faculty.

Accounting documents maintained by the project director are the sole source of financial data reported here. Explanations of ambiguous points were obtained from institutional accounting personnel. Data were directly available on hourly wages, annual salaries and benefits for each member of the staff, on investment in computer hardware, videotape equipment, and equipment for in vivo experimentation, and finally for consumables reported here as supplies for each content area. Costing by mode of delivery and content area required that algorithms be developed to allocate investment among content areas and within each content area by modes of instruction.

Costs incurred in the development of these modules have been analyzed from five perspectives: content area, mode of instruction, category of expenditure, stage of project activities, and source of funding (CAUSE or institution). The project director and the cost analyst agreed that it would be most useful to project personnel to allocate total project costs to the content areas which incurred the costs. Within each content area costs are allocated to the particular mode of instruction with which they are associated. The costs associated with developing the eight computer-based modules in social psychology, for example, are clearly identified. Costs are also identified by category of expenditure: personnel, programmers, supplies, and investment.

In the original grant proposal each module was associated with a specific laboratory course. This suggested that the course would be an appropriate analytical unit. Such was not the case, however. As particular experiments, computer simulations, and videotape sequences were developed, they served more than one course. Program elements developed for one module could be used in others thus reducing the development costs of modules which came later in the project. The experience gained by programmers and developers in one module reduced the time and cost of developing those which came later. Such shared costs and joint products made it impossible to isolate the costs of developing a particular module or course. Content areas and mode of instruction were thought by the project director and cost analyst to be the most detailed level of aggregation not seriously influenced by this joint cost/joint product consideration. All courses within a content area are consolidated as are modules within a particular mode of instruction. For example, only the total cost of computer simulations in biopsychology is shown, despite the fact that four separate computer simulations were developed; two for each of two courses.

Results

The project's total budget of $526,558 provides for the acquisition of capital and the employment of faculty members, graduate assistants and support staff to develop laboratory instruction modules in the six content areas within which psychology is taught at the university. Table 38 presents the budget as originally summarized in the project's proposal. Project funding specifically provides for the design, development and evaluation of approximately 125 modules. At the time of this cost analysis, work was underway on 43 modules, 31 using computer-based activities, eight using videotape sequences, and four using more traditional "hands-on" or "in-vivo" experimentation. Table 39 summarizes the status of these modules.

Allocation of faculty effort. The project director was able to estimate the proportion of time which each faculty member devoted to each mode of instruction. Professor A, for example, was reported to spend all of

Table 38

Proposed Budget for the CAUSE Project at Willows University

Line Item	NSF	Willows	Total
Salaries, Wages and Benefits			
11. Director	$ 16,768	$ 5,589	$ 22,357
12. Professional Staff	53,285	--	53,285
13. Assistants	47,000	97,000	144,500
14. Local Evaluation Specialist	--	12,546	12,546
15. Secretarial and Clerical	13,090	--	13,090
16. TOTAL: Salaries and Wages	130,143	115,635	245,778
17. Staff Benefits (when charged as direct costs)	12,369	3,542	15,911
18. TOTAL: Salaries, Wages and Benefits (16 & 17)	142,512	119,177	261,689
Other Direct Costs			
19. Guest Lecturers	--	--	--
20. Staff Travel	860	--	860
21. Field Trips	--	--	--
22. Laboratory and Instructional Materials	10,000	--	10,000
23. Office Supplies, Communications	5,100	--	5,100
24. Scientific & Evaluation Consultants	15,000	--	15,000
25. Renovation	11,000	--	11,000
26. Computer System	--	95,000	95,000
27. Other Laboratory Equipment	5,673	12,327	18,000
28. TOTAL DIRECT OPERATING COSTS (18 through 27)	190,145	226,504	416,649
29. INDIRECT COSTS (42% Line 18)	59,855	50,054	109,909
30. TOTAL OPERATING COSTS (28 & 29)	250,000	276,558	526,558

Table 39

Laboratory Modules Under Development

Content Area	Computer	Video	In Vivo	Total
Analysis of Behavior	5	2	0	7
Biopsychology	5	1	0	6
Developmental	2	1	1	4
Personality	7	1	1	9
Sensory	4	3	2	9
Social	8	0	0	8
TOTAL	31	8	4	43

Table 40

Professional Salaries

Content Area	Computer $	Computer %	Video $	Video %	In Vivo $	In Vivo %	Total $	Total %
Analysis of Behavior	5,011	8.3	9,272	26.9	3,571	54.4	17,854	17.6
Biopsychology	14,519	24.2	5,687	16.4	--	--	20,206	19.9
Developmental	6,762	11.2	11,571	33.5	--	--	18,333	18.2
Personality	15,435	25.6	2,035	5.9	--	--	17,470	17.2
Sensory	5,986	9.9	5,986	17.3	2,993	45.6	14,965	14.8
Social	12,516	20.8	--	--	--	--	12,516	12.3
TOTAL $	60,229		34,551		6,564		101,344	
% of Total Project Personnel	59.4%		34.1%		6.5%		100%	

his time on computer simulation development, while Professor K spent 20% of his time on computer simulation development, 70% on videotape sequences, and 10% on a new in vivo experiment.

The project director's estimates were corroborated by discussion with the computer programmer who did not know the original estimate offered by the project director. The cost analyst reconciled disagreements in conversations with each of the parties involved. An examination of the number of modules produced in each content area served as another mode of validation. In some areas a considerable amount of time was spent and very few modules were produced; in other cases the opposite was true. There appeared to be no evidence to suggest that reported time distributions were inaccurate. This distribution of professional effort in each content area was used to allocate costs in the area among modes of instruction.

As Table 40 shows, $17,470 was expended on hourly wages, annual salaries and fringe benefits for faculty members and graduate assistants in the personality content area. Of that total, $15,435 covered the cost of time spent on the development of computer simulations and $2,035, the time spent on videotape sequences. No effort was devoted to in vivo experimentation in this content area. Vertical summation yields the total value of project time spent on each mode of instruction. The percentages show the proportion of that time committed by each content area. Thus social psychology committed 20.8% of the total time and associated salaries to developing computer modules. It may be noted that 59.4% of project salaries was used in developing computer modules, 34.1% for videotape sequences and 6.5% for in vivo experimentation.

Allocation of investment. It was known directly from accounting data that $76,000 was spent on computer hardware, $25,000 on videotape equipment, and $7,000 on equipment for in vivo experimentation. All content areas, however, had access to the equipment and no record was kept of use by each area. The distribution of investment costs was therefore guided by the distribution of faculty time. Since 25.6% of the time spent developing computer-based modules was derived from faculty and graduate assistants in the personality areas, it seemed a good first approximation to assume that 25.6% of the investment in computer hardware should be allocated to the personality area. This procedure resulted in the distribution of investment among content areas shown in Table 41. Of the $108,000 in total investment, 70.4% was spent on computer hardware, 23.1% on videotape equipment and 6.5% for in vivo experimentation equipment.

Allocation of programmers. A similar procedure was followed to allocate programmers' time among content areas and modes of instruction. It was the project director's assessment that both programmers spent about 80% of their time on programming for computer-based modules. One spent the remainder of his time on central service functions; the other spent his time equally between central service and programming for videotape modules. The distribution of faculty and graduate assistant time within modes of instruction was once again taken as a guide to the allocation of time to content areas. The results appear in Table 42.

Table 41

Investment

Content Area	Computer		Video		In Vivo		Total	
	$	%	$	%	$	%	$	%
Analysis of Behavior	6,308	8.3	6,725	26.9	3,808	54.4	16,841	17.6
Biopsychology	18,392	24.2	4,100	16.4	--	--	22,492	19.9
Developmental	8,512	11.2	8,375	33.5	--	--	16,887	18.2
Personality	19,456	25.6	1,475	5.9	--	--	20,931	17.2
Sensory	7,524	9.9	4,325	17.3	3,192	45.6	15,041	14.8
Social	15,808	20.8	--	--	--	--	15,808	12.3
TOTAL	$76,000		$25,000		$7,000		$108,000	
% of Total Project Investment	70.4%		23.1%		6.5%		100%	

Table 42

Programmers' Salaries and Benefits

Content Area	Computer		Video		In Vivo		Total	
	$	%	$	%	$	%	$	%
Analysis of Behavior	958	3.3	304	26.9	--	--	1,262	17.6
Biopsychology	3,794	24.2	185	16.4	--	--	2,979	19.9
Developmental	1,293	11.2	379	33.5	--	--	1,672	18.2
Personality	2,955	25.6	67	5.9	--	--	3,022	17.2
Sensory	1,143	9.9	195	17.3	--	--	1,338	14.8
Social	2,402	20.8	--	--	--	--	2,402	12.3
TOTAL	$11,545		$1,130				$12,675	
% of Total Programmers' Salaries	91.1%		8.9%				100%	

It should be noted that the inaccuracy of using faculty and graduate student time as a guide to programmer time allocation may be substantial. The programming effort required is not necessarily proportional to the effort initially expended by the faculty in developing the idea. It was decided, however, that the programmers worked so closely with the faculty that in this case there should be no major discrepancies attributable to this algorithm.

Allocation of supplies costs. Available data permitted allocation of supplies directly to the mode of instruction within the content area with which it was associated. This is the last cost item which is associated directly with the development of particular modules. Supplies costs include the costs of consummable materials. They are allocated as shown in Table 43.

Summary of direct costs. All costs except those for renovations and administration/overhead have now been identified for the 43 modules currently in progress. These costs are summarized in Table 44. As shown, 47.8% of the direct costs for the design, development and testing of these 43 modules were attributable to investments in capital equipment. The time spent by faculty and graduate assistants in conceptualizing and designing the modules accounted for 44.8% of direct costs. Only 5.8% of the funds was spent on programming and 1.8% on consummables. The greatest portion of the direct costs, 20.7%, were devoted to biopsychology and the least by social psychology with 13.7%.

Table 43

Supplies

Content Area	Computer	Video	In Vivo	Total
Analysis of Behavior	$462	209	490	1,161
Biopsychology	263	209	359	831
Developmental	64	209	--	273
Personality	132	104	--	236
Sensory	660	416	180	1,256
Social	263	--	--	263
TOTAL $	1,844	1,147	1,029	4,020
% of Total Supplies	45.9%	20.5%	25.6%	100%

Table 44

Total Direct Costs
By Content Area and Categories of Expenditure

Content Area	Faculty & GA Compensation	Programmers' Compensation	Supplies Expend.	Investment Expend.	Direct Costs	% of Total
Analysis of Behavior	$17,854	1,262	1,161	16,841	37,118	16.4
Biopsychology	20,206	2,979	831	22,492	46,508	20.7
Developmental	18,333	1,672	273	16,887	37,165	16.4
Personality	17,470	3,022	236	20,931	41,659	18.4
Sensory	14,965	1,338	1,256	15,041	32,600	14.4
Social	12,516	2,402	263	15,808	30,989	13.7
TOTAL $	101,344	12,675	4,020	108,000	226,039	100
% of Total	44.8%	5.6%	1.8%	47.8%	100%	

Allocation of overhead and renovation costs. In addition to direct costs, there are also associated expenses for general project management and facilities renovation. These costs apply to all content areas and modes of instruction. Overhead costs include the salary and fees paid to the project director, external and internal evaluators, and support staff. These budgeted expenses amounted to $44,073. Renovation costs totaled $8,525. These costs were allocated across content areas in proportion to each area's share of total direct costs shown in the last column of Table 44 . The results of this allocation yield the total project costs shown in Table 45.[1]

Total costs for the project to date have amounted to $278,637. This represents 52.9% of the projected budget expended at a point approximately one-third of the way through the time allotted to the project's completion. At this point work had also begun on 34% of the proposed 125 modules. While a comparatively greater proportion of the project's resources have been expended than might be expected at this point in the project's life and progress, the size of this expenditure is justifiable given that it includes the cost of investment in capital goods that will endure throughout the project and beyond. Specifically, if the project's total costs to date are divided according to whether they represent design costs (mainly personnel costs associated with the first 43 modules) or investment costs (from Tables 40 or 41), then expenditures are allocated as shown in Table 46.

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[1] Renovation costs have been divided proportionally between computer and video modes of instruction in each content area since the innovations were intended to accomodate these modes of instruction rather than the IN VIVO experimentation.

Table 45

Total Project Costs
By Content Area and Type of Cost

Content Area	Overhead	Renovation	Direct Costs	Total Costs	% of Total Costs
Analysis of Behavior	$7,228	1,398	37,118	45,744	16.4
Biopsychology	9,124	1,765	46,508	57,397	20.7
Developmental	7,228	1,398	37,165	45,791	16.4
Personality	8,109	1,569	41,659	51,337	18.4
Sensory	6,346	1,228	32,600	40,174	14.4
Social	6,038	1,167	30,989	38,194	13.7
TOTAL	44,073	8,525	226,039	278,637	100

Table 46

Project Costs to Date
By Life Cycle and Mode of Instruction

Life Cycle	Computer		Video		In Vivo		Total	
	$	%	$	%	$	%	$	%
Design	101,119	55.2	50,579	65.2	10,414	57.9	162,112	58.2
Investment	82,002	44.8	26,969	34.8	7,554	42.1	116,525	41.8
TOTAL	$183,121		$77,548		$17,968		$278,637	
% of TOTAL	67.7		27.8		6.5		100	

At this stage of the project, then, 58.2% of the costs incurred have been associated with design activities and 41.8% with investments. As the project continues, design expenditures will gradually account for a greater percentage of overall project costs. Virtually all investments in capital goods have been completed already. Furthermore, it is anticipated that project operation will become more efficient as the project director and university officials spend proportionately less time in continuation activities than they did in start-up activities. It is also anticipated that once this project is complete, the marginal cost of operating these improved courses will be insignificant. Additional capital expenditures will not be figured until the present equipment wears out in about 10 years. Additional design expenditures will not be encountered until the content of the modules need to be updated-and given the elementary nature of the material presented in the modules it is unlikely that revisions will be necessary or frequent for quite some time.

Design costs by content area. The topics of the instructional modules being completed within each content area are identified in Table 47. Costs for developing these modules have shown little consistency either within content areas or within modes of delivery. The following discussion focuses only on the design costs of these modules since the inclusion of investment expenditures would necessarily inflate the costs of these early modules. Table 48 summarizes the cost information for all modules.

In the computer mode of instruction, the average design cost of a module was $2,389 and the average time committed to this effort was .45

Table 47

Module Topics and Modes of Instruction
By Content Area

Module Topic	Mode of Instruction Computer	Videotape	In Vivo
Analysis of Behavior			
Respondent Conditioning		X	
Shaping	X		
Reading Cumulative Records	X		
Schedules of Reinforcement	X		
Complex Performances		X	
Stereotypic Behavior	X		
Total	5	2	
Biopsychology			
Basic Concepts	X		
Action Potential		X	
Behavioral Biology of Ingestion	X		
Nature of Membrane Potential	X		
Behavior Genetics	X		
Natural Copulating Behavior	X		
Total	5	1	
Developmental			
Habitation in Infants	X		
Physiological Data Acquisition	X		
Piagetian Task			X
Mother Infant Interaction		X	
Total	2	1	1
Personality			
Test Construction	X		
Reliability	X		
Cognitive Differentiation and Integration	X		
Computation Techniques	X		
Test File Construction (from vendor)	X		X
Methods of Observation	X		
Subject Selection	X		
Experimental Manipulation and Learned Helplessness	X		
Observational Techniques		X	
Total	7	1	1

Table 47 (cont'd)

Module Topic	Mode of Instruction		
	Computer	Videotape	In Vivo
Sensory			
Increment Thresholds	X		
Dark Adaptation	X		
Optics		X	
McCullogh Effect		X	
Collor Mixture			X
Periodicy Pitch	X		
Taste Adaptation			X
Audio Tapes		X	
Acuity Gratings	X		
Total	4	3	2
Social			
Attitude Change	X		
Aggression	X		
Population and Environment	X		
Attitude Scaling	X		
Conformity and Compliance	X		
Persuasion (Mandel Effect)	X		
Conclusion Drawing	X		
Statistical Modeling of Social Problems	X		
Total	8		

of a full-time-equivalent (FTE) quarter. Work on videotape modules took an average of twice as long to complete (1.0 FTE quarters) and were nearly twice as expensive ($4,603 per module). The range of time and expense within each mode of instruction, however, was wide. The average cost of computer modules ranged from a low of $1,286 in the analysis of behavior area to $4,060 in developmental psychology. In the videotape mode the cost per module ranged from $2,199 in sensory psychology to $12,159 in developmental psychology.

There was little work done on the in vivo modules with only four modules involved in the project to date. They appear to be somewhat less expensive to design than computer modules ($1,898 per module) and require about the same amount of design time (.40 quarters per module). The number of modules is so small, however, that such data are not necessarily indicative of actual costs.

A wide variety of factors should be considered in any attempt to explain these observed cost differences. The complexity of the content being taught in the module was identified as a major factor by the project director as was the amount of experience the faculty member and project team had in working with the particular instructional mode. Modules developed early in the life of the project bear the costs of trial and error as the organizational structure and an effective work pattern evolve. Those modules developed later not only build upon accumulated experience but on specific computer program segments or techniques that are transferred from one module to another. The most important conclusion to be drawn from this way of viewing costs is that the experience of one project is but an imperfect guide to planning the costs and productivity of another

Table 48

Design Costs and Product Indicators
By Mode of Instruction and Content Area

e of Instruction	Analysis of Behavior	Biopsychology	Developmental	Personality	Sensory	Social	TOTAL
PUTER							
ign Cost	$6,431	17,576	8,119	18,522	7,789	15,181	74,068
Modules in Progress	5	5	2	7	4	8	31
Faculty/G.A. Qtrs.	1.10	3.10	1.50	3.75	1.60	3	14.05
ign Cost/Module	1,286	3,515	4,060	2,646	1,947	1,898	2,389
s/Module	.22	.62	.75	.54	.40	.37	.45
EOTAPE							
ign Cost	$9,785	6,081	12,159	2,206	6,597	--	36,828
Modules in Progress	2	1	1	1	3	--	8
Faculty/G.A. Qtrs.	2.10	1.40	2.50	.50	1.60	--	8.10
ign Cost/Module	4,892	6,081	12,159	2,206	2,199	--	4,603
s/Module	1.05	1.40	2.50	.50	.53	--	1.01
D							
gn Cost	$4,061	359	--	--	3,173	--	7,593
Modules in Progress	1	--	1	--	2	--	4
Faculty/G.A. Qtrs.	.80	--	--	--	.80	--	1.60
gn Cost/Module	4,061	359	--	--	1,587	--	1,898
/Module	.80	--	--	--	.40	--	.40
L							
gn Cost	$20,277	24,016	20,278	20,728	17,559	15,181	118,039
Modules in Progress	8	6	4	8	9	8	43
Faculty/G.A. Qtrs.	4.00	4.50	4.00	4.25	4.00	3.00	23.75
gn Cost/Module	2,535	4,003	5,069	2,591	1.951	1,898	2,745
/Module	.50	.75	1.00	.53	.44	.37	.55

similar project with different people in a different situation.

Analysis of faculty and graduate assistant participation. A total of 23.75 full-time equivalent (FTE) quarters of time were spent on the development of the 43 modules in progress at the time of this study. This included 9.25 FTE quarters of faculty time and 14.5 FTE quarters of graduate assistants' time. A total of 11 faculty members, excluding the project director, were involved in the project for various periods of time during the first five quarters.

In most content areas the pattern of participation was for one faculty member to be involved on a half-time basis during the summer of 1978 and to contribute total services equivalent to .5 FTE quarters during the following three quarters. A different faculty member was then involved in the project on a half-time basis during the summer 1979 quarter. The .5 FTE contribution over the fall, winter, and spring quarters was formally recognized by the university through a one-course reduction in teaching load during one of the quarters. (A normal teaching load is two courses per quarter.) The timing of the reduction, however, did not necessarily coincide with the period during which the faculty member was most active on the project.

There were several exceptions to the pattern of faculty participation described here. In sensory and in social psychology only one faculty member was involved in the project while in the personality area there were three faculty members participating. In biological and in social psychology .5 FTE quarters of faculty effort were contributed on an overload basis with no reduction in other responsibilities to offset the demands of CAUSE participation. Each content area also had the services of a graduate assistant during every quarter--the equivalent of 2.5 FTE quarters in each area.

Examination of the data in Table 49 shows no consistent relationship between the number of modules in progress and any of the other factors. Considerations other than the number of faculty involved and their total time commitment determine the rate at which progress is made in the project. Two faculty members and a graduate assistant working a total of four FTE quarters initiated work on four modules while one faculty member and a graduate assistant combining to put in an equal amount of time had nine modules in progress. There was not a sufficient diversity in the pattern of time commitment to determine whether a half-time commitment during the summer quarter enabled faculty members to work more productively than an equal-sized effort spread over three quarters.

Project costs by funding source. The university was budgeted to contribute $226,504 in direct operating expenses plus $50,004 of indirect costs for a total of $276,558. Of this total, $107,327 is for capital investment (as already complete at the time of the cost analysis). Renovation expenses had been budgeted for $11,000 but had actually cost only $8,000. The remaining $3,000 in the renovation budget was reallocated to equipment purchases with NSF's approval. Beyond the budgeted equipment purchases, however, the university has purchased six additional computer terminals out of its own funds. The cost of these additional terminals was not included in the original budget for this project and thus represents an addition of $36,000 to the institution's contributions to this project.

An additional expense not reflected in the budget is the cost of

Table 49

Analysis of Faculty Time Committed to CAUSE

CONTENT AREA	Number of Faculty	TOTAL FTE Faculty Quarters	Summer FTE Faculty Quarters	G.A. FTE Quarters	TOTAL FTE Quarters	No. Modules in Progress
Analysis of Behavior	2	1.50	1.00	2.5	4.00	8
Biopsychology	2	2.00	1.00	2.5	4.50	6
Developmental	2	1.50	1.00	2.5	4.00	4
Personality	3	1.75	1.00	2.5	4.25	8
Sensory	1	1.50	1.00	2.5	4.00	9
Social	1	1.00	.50	2.0	3.00	8
TOTAL	11	9.25	5.50	14.5	23.75	43

Table 50

Unbudgeted Contributions from Institution

Computer Terminals	$36,000
Faculty Salaries	53,285
Teaching Assistant	6,000
TOTAL	$95,285

faculty time on the project during the academic year. The original budget requested NSF funds to cover 1.5 months of a faculty member's time during the summer quarter for each year of the project. No university contribution to faculty time on the project was listed in the proposed budget (Table 38 although it was mentioned in the text of the proposal itself. Finally, in addition to faculty time, the university has also contributed the services of a graduate assistant not listed in the proposal. When the value of the university's contribution is calculated, it equals that funded by NSF, or $53,285. Table 50 lists the value of each of the university's contributions which are in addition to the original budget. The total of these additional contributions is $95,285, or an 18% increase over the original budget total of $526,558.

Discussion

The major cost factor in Willows University's CAUSE project is faculty time for materials development. Faculty time is a scarce and expensive resource for which there is a great deal of conflicting demand. In projects of this type, the project director must allocate the available resources in such a way that necessary compensation is available to insure adequate participation by faculty. When sufficient grant funds are not available to compensate faculty for their actual time commitment, then the cost of this time must be absorbed by the institution or the individual if the project is to continue successfully.

In the present project, Willows University noted in its original proposal that it would assume responsibility for covering faculty efforts in excess of the grant's original allocations. Reductions in teaching load were provided systematically to participating faculty and these reductions were reflected in their official "load reports" for the period involved. Load reductions, however, have not always coincided with the period during which the faculty member was actually working on the project.

Anticipating and accounting for faculty time requirements has been a sensitive and complex activity. It requires an understanding of the task requirements and faculty capabilities in a given area of project activity. It also requires identifying various means of compensating faculty in ways which are meaningful to them from summer support or course load reductions to the provision of graduate assistants and overload pay. This project has provided a good example of the time demands placed upon faculty in this kind of instructional improvement effort as well as the variety of means of compensating faculty for their time.

Conclusions

The project is still in progress at the time of this writing. All indications are that it is proceeding smoothly and will continue well past the formal funding period. One reason for its probable success is that the project is meeting a real and legitimate university need; i.e., the need for low-cost laboratory instruction in psychology for large numbers of students. Evidence of the reality of this need includes comments from university administration as well as project participants regarding the increasing importance of laboratory instruction in the university, the fact that the project has built on previous work in computer-based approaches to laboratory instruction in pyschology, and the university's continued commitment of real personnel and material resources to the project substantially beyond what was originally proposed. The full-time programmer's position has recently been made a permanent position at the university. University administration has also agreed to maintain the half-time evaluation position for three years for purposes of conducting a follow-up evaluation of the project and of the Psychology Department in general.

Computer-based and television-based modules are being produced as planned. However, it would be a mistake to view the major impact of the grant to be the production of 125 modules as significant an achievement as that might be. More important is the institutionalization of an innovative and probably effective response to an important need. Difficult procedural and managerial problems relating to the effective coordination and efficient use of resources are being challenged and solved. Lessons have been learned; solutions have been developed. Not only will the developed modules and acquired facilities remain after the completion of the grant, the processes and procedures necessary to continue the project will also remain.

Of particular value are the institutionalization of the processes of instructional development and evaluation. Faculty are asking questions about what they teach, how they teach it and why certainly more publicly and probably more frequently than before. This sort of systematic and purposeful thought about instruction is always useful and does not happen frequently encugh in university settings. The professional development of departmental faculty in this regard is a significant benefit of the project., The project director should be commended for the manner in which he has been able to nurture this professional growth and development within his institution without the backlash that often results when one tries to encourage independent souls to address the art of teaching in a systematic manner.

It is too early to assess the direct impact of the project on students, particularly in terms of the broad developmental goals cited in the proposal. However, the fact that the project as a whole (as well as individual modules) is built through a flexible, logical and continuing analysis of needs and potential remedies; the fact that these analyses are documented and thus subject to scrutiny; and the fact that initial solutions are empirically tested with students before they become etched in institutional granite all lead one to believe that the eventual impact on students will be real and substantial.

CHAPTER THREE
SITE VISITS TO SEVENTEEN CAUSE PROJECTS

Bay College

General Background

Focus:	Development of an interdisciplinary approach to teaching science by the "discovery" method
Budget:	From NSF: $123,400 From Institution: $61,687
Began:	June, 1977
Duration:	36 months
Date of Visit:	October 29-30, 1979
Visitors and Report Authors:	Terry Coleman and David Butts

Bay College is a small private, church-related liberal arts college located on a quiet, self-contained, rural campus in a small town with a population approximating 8,000. Total student enrollment at the college is approximately 480; faculty number 33 FTE; 20 of these are full-time. The college offers four major instructional program areas: Business, Education, Humanities, and Health and Science. Approximately 20% of the student body major in the Health and Science area, with the largest percentage of student majors divided between Education and Business.

The project was primarily the brainchild of the project director, an associate professor in Data Processing and Mathematics. The project grew out of concern among several science faculty that science instruction at the college was severely limited in pedagogical approach. The primary deficiencies as noted in the CAUSE proposal were that students were not being sufficiently exposed to the method and rationale of the scientific approach to inquiry and that interdisciplinary integration of scientific knowledge was not being stressed. These deficiencies, according to the proposal, were especially pronounced, given what was described as the very inadequate high school science backgrounds of many of the students.

Specifically, the objectives of the project were to:

-introduce students to science by the "discovery" method;

-increase the range of sciences offered and develop interdisciplinary courses; and

-modernize the techniques and equipment used in science laboratories.

Information on the Site Visit

We visited the project during its third and final year of CAUSE funding. We were particularly interested in determining what we anticipated were the special problems and issues in implementing a project of the scope described in the project's proposal at a small institution such as Bay College. Prior to the visit, we perceived the project plans to be very ambitious, particularly with respect to evaluation activities and were interested in seeing the extent to which the local context was able to support the implementation of these plans. We were interested in seeing the extent to which project plans needed to be adjusted in light of what we expected to be rather limited institutional resources and flexibility with respect to staff time allocation.

Toward these ends, our activities on site primarily consisted of several lengthy discussions with the project director; an extended conversation with another faculty member, a chemist, who had been instrumental along with the project director in implementing project activities; interviews with the three other health and science full-time faculty members; an interview with the part-time geology faculty member who had been hired specifically in the context of project activities; a meeting with the Dean of the College; and two hour long discussion sessions with each of two groups of three students who had been affected by project activities. In addition, we inspected various project files and documentation including project reports, course materials, student project reports, and a one-hour videotape program which had been produced by the project staff for purposes of informing various audiences of project activities. We felt that this agenda, which was arranged at our request by the project director, would provide us with a balanced view of project activities and their impact on a small college community.

A review of the project's proposal and presite visit discussions between the two visitors resulted in our approaching the visit with a very positive bias toward the goals of the project as articulated in the proposal. At the same time, however, we were somewhat skeptical of the extent to which the extensive project plans as espoused in the proposal were realistic given the situational constraints imposed by small institutional size.

Description of the Project

The project is called the "Earth Lander" project to reflect the unifying theme of the concept of a scientific vehicle landing on Earth and performing experiments to explore the environment, similar to the way in which the Viking Lander did on Mars. Five out of the six full-time faculty members of the Health and Science Program area have been involved to some extent in the project, although the major responsibility for project activities has been carried by the project director with substantial assistance from a professor of chemistry.

Project activities can best be described within three sets of interrelated activities: development of three new interdisciplinary courses, acquisition of an interactive computer system and other scientific equipment, and an expansion of science offerings.

Development of three new interdisciplinary courses. Two of the three proposed courses had already been developed and offered by the time we visited the project. The third course was to be offered during the Spring 1980 semester. A freshman course, entitled the "Discovery" course, was offered once to approximately 15 students in January 1978. This course emphasized the development of student understanding of the scientific method and employed a problem-solving approach in the conduct of relatively simple scientific experiments by students in a number of scientific fields (meterology, geology, biology, chemistry, astronomy). Subsequent to this first offering of the course, a two-week module on the scientific method was extrapolated and integrated into two core courses: Introduction to Physical Science and Introduction to Life Sciences. The revised module involved demonstration of experiments by course instructors (instead of student "hands-on" work) because of the large number of students in the core courses (up to 50, as opposed to 15 in the original Discovery course), and because of the limited class time (two weeks) allocated to the module.

A sophomore/junior course, called the "Earth Lander" course, was offered during January 1979 to approximately 20 students. Student teams replicated experiments performed during the Viking mission to Mars. A "landing site" on the college campus (including a complete weather station) was established and was used as the source of materials and samples for the experiments. Although the original intention was to offer the course a second time using multiple sites, the decision was made not to offer it again because (1) the second year activities had been expanded (biology and meterology observations continued for 12 months, not nine as originally scheduled, and visual imaging was also expanded), and (2) faculty did not have time to complete the elaborate preparatory and implementation activities for other sites.

A senior seminar which is intended as a culmination and integration of the experiences and work completed as part of the sophomore/junior Earth Lander course was scheduled to be offered during the Spring 1980 semester.

Acquisition of interactive computer system and other scientific equipment. A PDP 11 interactive computer system has been installed and has been operational since December 1977 together with a graphics terminal and plotter. In addition, various pieces of scientific equipment have been acquired, including: a Warburg apparatus, a gas sampling valve for the gas chromatograph, and meteorological equipment. The computer and other equipment have been used in conjunction with the two courses already offered (freshmen "Discovery" course and sophomore/junior "Earth Lander" course) and have been used in other science courses as well, primarily for the purpose of processing and summarizing scientific data. In addition, two faculty members (one in science and one in the humanities program) have developed tutorial programs on the computer. Some difficulty has been encountered in acquiring appropriate computer interfaces at a realistic cost and developing software to run the interfaces. At the time of our visit, the project director estimated that approximately 40% of the interfacing had been completed.

Expansion of science offerings. A geologist was added to the Health and Science staff for the purpose of development of a geology curriculum. A major problem was encountered in attempting to hire a half-time geologist for the second and third project years. A qualified geologist could not be found who was willing to work on a half-time basis. The monies for the half-time position (for the second and third year) were pooled to hire a full-time geologist for the third project year. During the Fall 1979 semester, the geologist taught a course to faculty for the purpose of developing Health and Science faculty expertise in the area of geology, supervised a student working on a directed student geology project, developed several geology courses and revised the existing earth science course and consolidated the college's geology collection which has been in a state of disrepair for some time. During the Spring 1980 semester he taught three geology courses. It is unlikely that the college will be able to support a faculty position in geology once CAUSE funding ceases.

Issues

Institutional needs. The Health and Science program at Bay College identified the need to strengthen their program in order to take into account what they perceived as deficiencies in students' science backgrounds. Specifically, three needs were identified: deficiencies in the instructional approach of science courses, lack of adequate equipment, and lack of breadth of science offerings. To meet these needs, several courses of action were proposed including the addition of several interdisciplinary courses, the acquisition of an interactive computer system and other scientific equipment, and the addition of a new curriculum area to the program (geology). Being a small, private institution with rather limited resources, however, the institution was not able to provide the resources necessary to implement these specific actions. The CAUSE grant very definitely met institutional and science education needs in this respect.

Without support from CAUSE, it is unlikely that the perceived needs of the Health and Science program would have been met.

The CAUSE project activities enjoy strong verbal support from the administration. Unfortunately, however, it is unlikely that the administration will be able to find the resources necessary (both in terms of dollars and faculty time) to continue some of the innovations wrought by the project. It is not clear whether the two courses developed and offered under the auspices of the project will become part of the college's regular course offerings. It appears fairly evident that the geolgist will not continue on staff.

At least two situational factors have inhibited more extensive institutionalization of project activities. Enrollment in the college, particularly in the sciences, has dropped considerably from previous expectations. Courses such as Microbiology and Astronomy, for example, have dropped in enrollments from about 30 to enrollments of 6-8 students. Some courses relevant to the project (e.g., Terrestial Ecology) were cancelled because of lack of enrollment. The drop in enrollment made it difficult to integrate the project into existing courses with decreasing enrollment and even more difficult to add new courses and/or staff to a curriculum which already had too many courses for the number of students available.

A second situational factor stems from a large ($400,000) grant which the college received in 1978 for the purpose of establishing a medical technology program. Two major grants operating concurrently in the same general academic area resulted in the spreading of faculty resources extremely thin. An additional issue raised by the medical technology grant is that of career education versus liberal arts. The medical technology grant was very career oriented, whereas the CAUSE project was aimed at the more abstract goals of liberal arts science education. As the project director pointed out, in the case of a conflict, most students at Bay College choose the course necessary to fulfill requirements for medical school, or the med tech program, not the course devoted to teaching them the real nature of science. This makes changing courses such as those emanating from the CAUSE grant from "special" courses to regular, even required, courses extremely difficult.

Project implementation. Two key factors appear to have promoted successful completion of most proposed project activities. One of these is the commitment, hard work and leadership of the project director. He personally ensured that project tasks were completed and earned the respect and support of the administration and other faculty. A second important factor is that the project included almost a full year of front-end planning time. This helped ensure that the necessary equipment was installed and made operational and allowed sufficient time to develop specific plans with respect to offered courses.

Several factors which have hindered project implementation have been encountered. It appears that although the entire Health and Sciences faculty in spirit have supported the project, the major burden of work has fallen to the project director and one other faculty member. This appears to have been due primarily to an extremely heavy teaching load (averaging 27-28 contact hours per semester) which prevented more active participation. This problem was exacerbated by the fact that release time allocated in the proposal never resulted in real time available for faculty to work on project activities.

The project plans, as originally stated in the proposal, were probably somewhat overambitious. The project director spoke of a "cascading effect" of project activities from year to year. In addition, there were some unavoidable problems encountered, such as inability to find adequate consultants for various project activities and as previously mentioned the college's inability to find a part-time geologist.

Quality of instruction. The CAUSE project has had several positive impacts on instruction. Agreement seems to exist both among faculty and students that the courses offered under the aegis of the project were innovative and highly successful approaches to developing understanding of the scientific method and its applications among students who took the course. Evidence exists that the approaches developed for these courses have had (and will have in the future) important "spillover" effects on other courses offered by the Health and Sciences program. Specifically, a two week module (which is essentially a "condensed" version of the freshman Discovery course) has been integrated into two of the college's core science courses. In addition, the project director reported that some of the experimental procedures developed as part of the sophomore/junior Earth Lander course will be incorporated within at least two courses: Microbiology and Instrumental Analysis.

Overall, however, the long term impact of the project on science instruction at the college probably will not be extensive. In addition to the problems associated with implementing project activities (release time inadequacies, course enrollment problems at a small institution), we have recently learned that the project director has accepted a position in industry. Thus, the possibility of maintaining continuity in project activities and integration of these activities into normal institutional operations has probably been additionally threatened.

Evaluation. The College's CAUSE proposal described a series of evaluation activities which were very ambitious in scope. While the project director was able to complete some of these activities, he found that the evaluation plans, as stated in the proposal, were probably somewhat unrealistic. Evaluation activities included measurement of pre- and post-performances of students in project-related courses, student ratings of these courses, and expert review of the project. It appears that these activities have had some impact on project plans and directions. While he was convinced of the importance and need for evaluation, the project director felt that evaluation activities can tend to take more time than expected to the exclusion of other important project activities.

Summary

The CAUSE project at Bay College provided the opportunity to observe the problems encountered in implementing curriculum development innovations at small higher education institutions. The impact of the project in terms of its immediate effects on the learning experiences of students was highly evident. Uncertainty about the project's long term institutionalization, however, raises some questions about its ultimate impact.

Blue Meadows State College

General Background

Focus: Establishment of a biolearning center

Budget: From NSF: $70,600
From Institution: 61,000

Began: June, 1978

Duration: 24 months

Date of Visit: November 1-2, 1979

Visitors and Report Authors: Terry Coleman and Marvin Druger

Blue Meadows State College is a small rural junior college, one of twelve in the state. Established approximately 60 years ago as a junior/senior high school to serve a predominently American Indian population, the institution evolved first into an agricultural school and then into a junior college with two-year programs leading to the Associate of Arts degree. The school serves approximately 1350 students; faculty include 40 full time and part-time instructors. Over the past several years, the institution has been experiencing a 3-4% annual growth rate.

The State Board of Regents several years ago mandated an open door policy for all junior colleges in the state. This has resulted in a student population with very diverse backgrounds and abilities. An instructor in the Biology Department had for several years been developing and using in his classes biolearning modules (audio taped lectures and study guides on particular topics) in an effort to derive a course delivery mechanism which would allow for flexibility in dealing with the personalized styles and abilities of individual students. The CAUSE project was envisioned as an expansion of these efforts.

Specifically, the objectives of the project as articulated in the CAUSE proposal were to:

-establish a Biolearning Center;

-adapt the courses, General Biology, Botany, and Zoology to a multimedia approach;

-design alternative pathways for students of varying backgrounds, capabilities and interests;

-continue evaluating materials, personnel, logistics, and learning accomplished.

Information on the Site Visit

During the two day visit to the project we met with the project director who is a biology instructor, the Biolearning Center Coordinator who was hired with CAUSE monies, an instructor of botany and general biology who had only recently been hired to fill a regular vacant position in the science department and who was required to use project developed materials in a course he teaches, several students who were enrolled in a zoology course taught in the biolearning center, the director of counseling and developmental education, the director of the library/learning resources center, the dean of the college, and the president. In addition, we observed a biolearning center course and reviewed several sets of instructional materials which had been developed as part of project activities. The project director arranged the schedule following a pre-visit request to meet with individuals at the college (faculty, students, and administrators) who had been directly involved or affected by the project and some who had not.

Subsequent to pre-visit reviews of the project's proposal and a site team conference, we both agreed that the plans outlined in the proposal were ambitious, given the rather limited people resources and the relatively short timelines (24 months). We were therefore interested to see the extent to which project objectives had been accomplished after almost 75% of the projected project timeline had expired. In addition, we both agreed that the proposal had been somewhat less than specific in identifying the particular types of strategies which would be used in operationalizing various instructional strategies (e.g., alternative pathways). Thus, we were interested in determining how these instructional strategies operated in practice. A third overall aim of our visit was to gain an understanding of the problems encountered in implementing a project of the scope described in the proposal at a small college like Blue Meadows State which had limited flexibility in terms of faculty resources.

Description of the Project

Each of the three freshman courses (General Biology, Zoology, and Botany) which were the focus of the project's development efforts is a one-semester course. Non-science majors take the General Biology course which enrolls about 30 students. After completing the General Biology course, the non-science majors take a course in General Physical Science. Science majors take the Zoology course and the Botany course. At the time we visited the project, the Botany course had 18 students and the Zoology course had 16 students enrolled. All three courses were being offered concurrently.

Prior to the CAUSE grant, the project director had developed approximately 60 audiotape modules for use within the General Biology course. Since, according to the project director, these modules were not sufficiently lab oriented, he began development of entirely new modules. The previously developed modules are now used in conjunction with a general biology course taught at an off-campus education center which is about 30 miles from campus.

The intent of the project was to develop alternate course pathways for students with different backgrounds and interests. The main course material is taught by utilizing audiotapes and text reading assignments. Course exams are based upon these two aspects. Supplementary materials include videotapes, live lectures, slide-tape and filmstrip-tape programs, film loops, and individual and group lab activities, all of which are available in the Biolearning Center. A mini-computer has been purchased by the school (partly with CAUSE money), and plans call for the development of some supplementary course materials using this medium.

At the beginning of the first semester, every new science student takes a diagnostic exam, which was written by the project director, and completes a commercially available testing instrument, which is intended to identify the kind of learning environment in which the student functions best. The course instructor interviews each student in the course concerning results on these tests, and attempts to use them in a diagnostic and prescriptive manner, directing students to the different types of supplementary materials available.

Students in all three courses complete the first six learning modules. Then the courses diverge, and each course focuses on its specialties (zoology or botany). In each course, everyone takes the same exams on the text readings and audiotaped materials. Beyond the audiotape and text core, learning options are available for different ability and interest levels. For example, a bright student might do a research project; a poor student might be designated for tutoring. No specific set of instructional options or learning activities define the alternative pathways. Instead, the concept refers to a counseling approach to seeking supplemental and remedial learning experiences for individual students enrolled in a course.

The General Biology, Zoology, and Botany courses are taught in the new Biolearning Center which was renovated and outfitted with CAUSE monies. Prior to the establishment of the Center, a section of the library had been used to store and utilize the audiotape General Biology modules developed prior to the CAUSE project. The Biolearning Center is a large room ringed by 24 carrels. Each carrel is equipped with a tape recorder with a five-channel system and headset. A lab table and a teacher's desk are also present. A TV monitor is available in the room. A preparation room is adjacent to the Biolearning Center. The center is staffed by a coordinator. Each semester, two student tutor assistants are employed to work in the library to help students in the Biology, Zoology, and Botany courses. Each tutor assistant is scheduled to spend about six hours per week in the library to help students. It was reported by the project director that not much use has been made of these tutor assistants by the students enrolled in the courses.

The audiotape modules are brief, taped lectures. Each module requires about one hour to complete. Regular class sessions are scheduled and students are expected to attend class and utilize the appropriate tapes and guide sheets. Students can also use the audiotape modules to complete their assignments at other times. The Biolearning Center is open from

8:00 AM to 5:00 PM during the week and Monday nights.

We listened to the audiotapes and examined the accompanying guide sheets for several of the General Biology modules. The guide sheets specify the learning objectives and learning activities. Students take notes and answer questions on the guide sheets as they listen to the tape. The guide sheets appeared well organized and the content seemed accurate and appropriate for an introductory college-level biology course. The tapes were straight lecture. Each tape started by specifying the learning objectives. Each ended with the statement: "This concludes this module. Please rewind the tape." The taped lecture generally sounded like the narrator was reading from a book. No specific lab work was incorporated into the structure of the learning modules which we reviewed. The project director indicated that there are some dissections and field trips in the course, but that the lack of an adequately equipped laboratory inhibits the incorporation of much lab work into the course.

The project director has developed 60 new modules since the inception of the project. These modules cover most of the course content of both the General Biology and Zoology courses. All the Botany course modules had not as yet been developed at the time of our visit to the project.

The modules are used by the other two instructors who teach the General Biology and Zoology courses. One of these instructors is the science department chairperson who, according to the reports of several individuals we interviewed, was initially resistant to the audio tape module concept but now is relatively enthusiastic. Unfortunately, he was out of town at the time we visited the project and we were therefore unable to talk with him. The other instructor who uses the modules in his General Biology course was new to Blue Meadows State College; he had taught there for approximately one-half the semester at the time of our visit. The person who was originally designated in the CAUSE proposal to develop and teach the Botany course left Blue Meadows State College for another job. She was replaced by an interim person, and only recently was a full time faculty member hired to teach the Botany course. This personnel problem has delayed the development of the Botany course materials.

The new Botany instructor was hired with the understanding that he would be using the audiotape modules in his General Biology and Botany courses. When we spoke with him, he was not enthusiastic about the approach. He felt that he was personally more effective as a teacher when he could lecture and have more "personal contact with students". He reported that he would probably continue to use the audiotaped modules for the General Biology course, but that he intended to return to a lecture/lab approach for the Botany course next year. He indicated, however, that certain topics lend themselves well to the audiotape appraoch and that he would incorporate these into the Botany course as appropriate.

Several difficulties were encountered in implementing project activities. The person who was first hired for the position of Biolearning Center Coordinator did not work out well and was urged to resign after about nine months of work. The present coordinator has worked out very well, but no funds are available to continue her employment beyond the period of the CAUSE grant. It is anticipated that student tutors will be hired to replace her, and that the program can continue without major disruption due to her absence. The main purpose of the coordinator was reported to have been to provide work relief for the project director while he was developing the course modules.

Although administrative support for the CAUSE project seems strong, there was faculty opposition to the Biolearning Center approach. This opposition was supposedly stronger initially, and reactions were reported to have become less pronounced as the program became established. We noted several reservations on the part of administrative personnel which stem mainly from the concern that the audio tape module approach would de-emphasize reading skills development. There were some problems concerning logistics, such as obtaining equipment and materials on time. Also, the construction did not proceed as quickly as anticipated. The project director reported that he did not fully realize how time-consuming the development of the audio tape modules would be; he would have requested a third year of support from NSF in the proposal if he had realized this problem would exist.

Evaluation of the project is not being done as extensively as anticipated. Evaluation gets little attention because of the needs involved in actually developing materials. Moreover, the project director indicated that he is not trained for evaluation and does not view himself as skilled in this area.

Issues

Institutional needs. The CAUSE project at Blue Meadows State was envisioned as a means of ameliorating the perceived problem of coping with a student population extremely varied in background and ability. The CAUSE grant has provided the resources necessary (and otherwise probably not available) to upgrade facilities and to upgrade locally produced instructional materials. To this end, the CAUSE grant has helped meet the science education and institutional needs of Blue Meadows State College.

From another perspective, however, the CAUSE project has probably been even more instrumental. The project has stimulated awareness, activity, and controversy concerning alternative instructional methods in a school where traditional teaching has had strong support in the past.

Project implementation. The project is heavily dependent upon the project director. He wrote the proposal and has developed all the teaching materials thus far. He impressed us as an excellent teacher who has a great deal of talent and energy. Although the administration maintains that the project would continue even if he left, several factors make this somewhat questionable. The new faculty member is not enthusiastic about the use of audiotutorial methods; it is not clear as to whether or not the department chairperson (whom we did not have the opportunity of interviewing) is strongly in favor of this approach. It might be difficult to hire someone with the talents and energies of the present project director to continue the program.

The administration expressed strong verbal support for the project and yet articulated some reservations about the instructional approach involved. The support is apparently based both upon the pragmatic need for such alternative modes to meet the needs of the diverse student population, and upon the enhanced prestige gained by Blue Meadows State College as a regional pioneer in adopting innovative alternatives to traditional science teaching.

Improvement of instruction. The project director feels that the audiotutorial approach is providing the students with a better course than previously, but there is little solid evidence to support this view. Since the audiotutorial approach has totally supplanted the traditional lecture format, no valid comparisons between the two approaches can be made.

Student reaction to the CAUSE project is very favorable, as evidenced by remarks made to us during the visit. They liked the fact that they could learn at their own pace, and could complete the units according to their own schedules. They could use the audio tape scripts (which are available for each module) instead of the tapes, which seemed to them to be a faster mode of learning. They could learn the pronunciation of unfamiliar words from the tapes. A class discussion once every two weeks enabled them to review current material. In general, they seemed to like the idea that they could learn more in a shorter period of time by this method. The students also offered some criticisms of the program. They said that the program was sometimes monotonous, and that they would like to do more lab work and have more field trips.

Alternative pathways for students are not yet fully developed. The program currently relies mainly on tapes and scripts, with little laboratory work. Since exams are based upon text readings and the tapes, alternatives such as special projects, filmloops, filmstrips, etc. are purely supplementary and learning is not measured for these aspects. It might be that some students simply focus on the tapes (or even more so on the scripts) to learn the core materials efficiently and quickly, and that they are not oriented toward supplementary alternatives beyond the core. However, the project director is working on additional supplements and admits that more work is involved than he originally anticipated.

The prestige factor seems to be an important outcome of the CAUSE project at Blue Meadows State College. Several comments from different individuals supported this observation. Receiving the CAUSE grant was in itself a sign of support from NSF and drew attention to the project. Individuals from other institutions have visited the project to see it in action, and the project director and Blue Meadows State College have become regionally known for this work. This increased visibility is likely to enhance the institution's prestige and thus its abilities to marshall resources, talents, and energies to engage in additional efforts which will ultimately lead to improved instruction for students.

Evaluation. Evaluation in this project poses a problem for the project director and the college. The project director does not consider himself to be a good evaluator. He has no training in this area and he has devoted his energies toward developing instructional materials. Evaluation gets pushed aside because of more "immediate" needs. He suggested to us that it might have been useful to budget money for outside evaluators; he remarked that knowledge of potential external evaluators or evaluation agencies might have helped him at the start of the project.

Summary

This project involved the establishment of a biolearning center and the development of mediated instructional modules. The primary focus of the project was to provide a means of accounting for the varying abilities and interests of individual students in three science courses. Over a two-year period, the primary objectives of the project have been achieved primarily through the efforts of the project director. The degree to which the project has been institutionalized in the sense of its acceptance on the part of other science faculty members is at this point undetermined.

Clay College

General Background

Focus:	A comprehensive revision of the analytical chemistry program
Budget:	From NSF: $95,500 From Institution: 33,250
Began:	July, 1976
Duration:	36 months
Date of Visit:	November 8-9, 1979
Visitors and Report Authors:	Terry Coleman and Robert Yager

Clay College is a private, church-related undergraduate college with a full time student enrollment of nearly 2,000. Many of the students commute from their homes and most graduates (75%) remain in the area following graduation. The college is highly science-oriented with over 25% of all undergraduates majoring in the natural sciences.

The department of chemistry at Clay was recently listed in a survey conducted by the Council on Undergraduate Research as fifth in the nation for percentage of its graduates who have continued their education to earn the Ph.D. in chemistry in a ten year period surveyed (1965-75). It is considered a "prestigious" department on the campus as reported by administrators, faculty (in and out of chemistry), and students.

Analytical chemistry, however, was perceived as a weak program area within the department in 1976 when the proposal for a CAUSE grant was initiated. In its review of the Chemistry Department in 1975, the Committee for Professional Development of the American Chemical Society noted this weakness. The decline purportedly paralleled a national trend of the late sixties when analytical chemistry was deemphasized. Although the national trend was reversed, such attention was not given to the program at Clay. Improvement in other aspects of the chemistry program had occurred (i.e., biochemistry, physical chemistry, and organic research).

The major goal of the project (the revitalization of the analytical program in chemistry) was to be achieved through the following three objectives:

- -The broadening of student analytical capabilities through a revised analytical curriculum and research program;
- -Modernization of the analytical laboratory and instrumentation; and
- -Updating of faculty training in analytical chemistry and modern pedagogical techniques.

Information on the Site Visit

We visited the site during its final year of CAUSE funding. Our overall aim was to review project activities and outcomes over the course of almost three years of project activity. Since the visit occurred during what originally had been planned as the termination phase of the project, the visit afforded the opportunity to assess the results of many project facets. In addition, since a one-year extension had been granted to the project, the site visit team was also afforded the opportunity to observe the staff and students at work in planning for 1980 project activities.

During the visit we held several conferences with the project director; interviewed each of the other Chemistry Department faculty; spoke with the President of the College, Dean of the College of Arts and Sciences, the Associate Dean, and the Executive Vice President for Academic Affairs; and held informal discussions with several students who were chemistry majors. The strategies and activities outlined in Clay College's CAUSE proposal served as the organizational thread for the interviews conducted. Specific attention was directed at determining the extent to which project activities could be viewed as having had impact on the chemistry program and at the changes in project implementation activities which had occurred over the course of the project.

Description of the Project

Project implementation has centered on three sets of activities, each paralleling one of the three major objectives of the project: curriculum revision, laboratory modernization, and faculty training. The project director, an analytical chemist himself, is also chairperson of the department. He has been primarily responsible for and has taken the prinicpal role in the implementation of project activities. In addition, two other analytical chemists on staff have been involved. To a lesser extent, the majority of the other seven Chemistry Department members have participated, primarily as participants in faculty training sessions.

The primary curriculum development efforts of the project have centered on the expansion of course offerings in analytical chemistry. Through the efforts of the three analytical chemists in the department, two separate analytical chemistry courses were established in place of the one which was in existence prior to the CAUSE grant. The first of these courses (Chem 230), intended as a sophomore level course and recommended for chemistry majors, is an instrumented introductory course. It currently attracts medical technology and biochemistry majors in addition to chemistry majors. It differs from the pre-CAUSE junior level course primarily in that the number of topics has been reduced but covered in more depth. The topic areas which were eliminated from the first course are now covered in Chemistry 430, a senior level analytical course. This course generally enrolls only chemistry majors.

In addition to the curriculum development efforts involving these two courses, a junior level course, Spectrometric Analysis, has been changed in focus. Previously, the course covered a wide area of synthetic and structural organic chemistry; presently the course can be better described as instrumental organic qualitative analysis. In addition to chemistry majors, this course also attracts some biochemistry majors.

Course revision was primarily the responsibility of the relevant course instructor(s) although a project advisory committee provided substantial input to the curriculum revision process. This committee consisted of a chemist from a nearby university, an official of the Food and Drug Administration, and an industrial chemist from a local corporation. Work on the curriculum revisions took place during the first summer semester after grant funding.

In addition to course revision, a faculty-student summer research program has been established. In the past, it was reported that faculty had been very active with research participation grants for undergraduate students which provided on-campus research opportunities for faculty during the summer months. During recent years, however, many faculty have found support during summer months in industrial and university laboratories. Through CAUSE grant monies, the department is now attempting to re-emphasize faculty-student research on campus by providing support to both faculty and students for research activities.

This aspect of the project got a slower start than anticipated due to previous faculty commitments during the summer months. Thus, the project director requested and received permission from NSF for a time extension of the grant period to allow an additional summer session for research projects. During the 1979 summer session several research projects were conducted. This work resulted in several scholarly publications and presentations for faculty and students alike. The project director reported that he expected four or five of the faculty to be participating in similar projects during the 1980 summer session.

In order to meet the needs of the increased emphasis in analytical chemistry reflected in the course revisions and additions and in the initiation of a faculty-student research program, an analytical research laboratory has undergone major renovation and additional instrumentation geared specifically to analytical chemistry needs has been acquired. The lab which it replaced (viewed by the site visitors through photographs) had been in a dire state of disrepair. The new lab is modern and contains several pieces of relatively sophisticated equipment. Some faculty offices were also modernized during the grant period.

The third major focus of project activities has been on faculty development. Project monies have allowed Chemistry faculty members to attend short courses on particular topics sponsored either by the American Chemical Society or by individual colleges or universities. At the time of the site visit, five faculty members had attended these courses. The short courses attended were in areas of analytical skills such as thin layer chromatography and liquid chromotography. According to faculty who have attended them, these courses have helped keep them up to date on recent developments in the field which in turn helps keep the content of their courses up to date.

Project evaluation has not occurred as planned, according to the project director and several other of the faculty interviewed. Originally it was proposed that the advisory committee to the project would have primary responsibility for implementing evaluation activities. While the committee served a very useful function in providing assistance with the purchase of equipment and in suggesting content and techniques to be included in the curriculum, its function as an evaluative body was very limited. According to one faculty member interviewed, outside evaluators (such as the advisory committee) cannot provide for a totally meaningful evaluation of a program because they do not get the opportunity to really understand the project as it operates. This same faculty member thought that generally evaluation was regarded as more important at the administrator level than at the faculty level since sometimes it is the only real contact which an administrator has with a program.

Issues

Institutional needs. The Department of Chemistry at Clay College is a strong, agressive department, proud of its accomplishments and generally held in very high regard by other faculty members in the school and the administration. Its prominence and the apparent quality of its faculty are probably somewhat unique for an institution the size of Clay College. The analytical chemistry program was in need of revitalization and the CAUSE project seems to have filled a void for which resources otherwise unlikely would have been available. Thus the project has contributed to maintaining and increasing a particular strength of the institution (i.e., its science offerings).

The project appears to have been more of a vehicle than a catalyst for change. Widespread agreement had existed among the faculty of the department that analytical chemistry was an area in need of sustained attention.

Project implementation. No major problems were encountered in implementation of project activities. Project functioning became subsumed within department functioning. We found it somewhat difficult to discriminate, for instance, aspects of the CAUSE project from aspects of normal department operation.

Quality of instruction. There appears to have been general course improvement as viewed by faculty opinion and student reports. Student involvement, individual projects, and the prestige of the department campus-wide tend to attest to the quality of the instruction. Surely not all of this is directly attributable to the CAUSE project *per se*. However, the CAUSE project has resulted in improved capabilities in one area of the Chemistry program.

Evaluation. We found no great enthusiasm for evaluating the CAUSE project *per se*. The NSF grant provided a means to an end and that in itself is "evaluation" in the eyes of the Chemistry faculty. The high ranking of Chemistry graduates, their success in medical and graduate schools,are cited as testimonials to the quality of the program. The revitalized analytical program and the new emphasis upon faculty/student research is seen as resulting in improvement *by definition*.

Summary

Clay College's CAUSE project served as a means for the revitalization of an analytical chemistry program. In addition to curriculum revisions, faculty professional development activities, and the renovation of lab facilities, a particular outcome of this project has been the establishment of a viable faculty-student research program. The high level of integration into normal Chemistry Department functioning which this project evidences undoubtedly resulted in part from the fact that it was perceived by department faculty members as a means to an agreed upon goal.

Coastal University

General Background

Focus: Education for furthering environmental cognizance and training, Department of Geography

Budget: From NSF: $225,800
From Institution: 95,622

Began: Summer, 1976

Duration: 36 months

Date of Visit: November 15-16, 1979

Visitors and Report Authors: Jane G. Cashell and Jacquelyn Beyer

Coastal University is a large state university. If offers graduate and undergraduate degrees in a wide variety of academic areas and enrolls approximately 20,000 undergraduate and 11,000 graduate students. Coastal is considered a leading higher education institution in the country. Many departments are preeminent in their respective disciplines and professions.

The Department of Geography at Coastal University was awarded a CAUSE grant three years ago. It offers two undergraduate majors. Geography is one and the other, initiated in 1971, is analysis and conservation of ecosystems. During the 1960's and 70's, there has been a huge increase in the quantity and complexity of legislation intended to protect the quality of the environment. As a result of this new legislation, many more environmental scientists are needed to enact and to monitor government and industrial activities. The effect on the Department of Geography has been to greatly increase the number of majors and of undergraduate enrollments.

The faculty response to the enrollment increase has been to consider ways to upgrade undergraduate offerings. The focus of the changes in undergraduate environmental courses is on increasing research experience--both in the field and in the laboratory. The Chairman of the Department organized the proposal for the CAUSE project. He solicited requests from individual faculty members for new field and laboratory equipment and facilities which were needed for research studies in undergraduate courses.

The process of obtaining a CAUSE grant for Coastal University was initiated by the Vice-Chancellor. He informed divisional deans--Life Sciences, Social Sciences, Physical Sciences, and Humanities--about the initiation of the CAUSE program. Each dean was asked to nominate a department to apply for a grant. The Department of Geography was selected by the Vice-Chancellor from three departments nominated.

The objective of this project is to improve the instructional resources in the Department of Geography for undergraduate majors primarily in environmental courses. This was accomplished by providing new laboratories in physical geography, biogeography, and remote sensing and by establishing new field sites. New equipment was purchased or constructed. Courses were redesigned by individual faculty members to incorporate new or additional laboratory and field experiments. Support personnel of a lab technician, teaching assistants, and clerical help was provided with CAUSE funds to help with these changes. The objectives of the project as stated in the proposal are broadly defined:

> The Department's goal is to improve the quality and effectiveness of its undergraduate programs concerned with the environmental challenges facing society. This will be

achieved by augmenting the Department's instructional resources in several coordinated areas by CAUSE funding, and by developing the resources of the state as a vital field laboratory for the purposes of undergraduate education. There are presently excellent employment prospects in the state and farther afield for students who have benefited from an environmental education of excellence and high quality.

Information on the Site Visit

We worked together as a site visit team to interview, speak informally, observe, and tour facilities. After the site visit we read interim reports and other documents from the project and the department. Jacquelyn Beyer telephoned one faculty member who was out of town during the visit. The faculty members we met and interviewed are:

Project director, Professor of Geography, former Chair of the Department, and Dean of Social Sciences;

Associate Professor of Geography, instructor of the courses Biogeography, Animal Geography: Biophysical Aspects, and Animal Geography: Cultural Aspects;

Professor of Geography and instructor of a new course, The Earth from Above;

Associate Professor of Geography and instructor of the courses Ecology of Vegetation, Environmental Impact Analysis, and Field and Laboratory Analysis: Biogeography;

Professor of Geography and instructor of the courses, Climatology and Field and Laboratory Analysis: Climatology;

Professor of Geography and Department Chair;

Associate Professor of Geography;

Three geography students who are department research and teaching assistants;

Laboratory Technician.

Our schedule was established by the project director. We asked him to make appointments for us to interview him "as well as faculty and staff on the CAUSE project, possibly some science faculty who are not a part of

CAUSE, some students, and university administrators." We did not specify whom precisely we wanted to interview either by name or job title. When we arrived at Coastal University the project director had arranged for us to interview all the people listed above except the last Associate Professor of Geography listed. He was out of town and was interviewed by telephone. We worked very closely with the project director during our visit.

Before beginning our site visit, we reviewed the proposal, established a focus for the visit, and discussed our personal reactions to the proposal. Since the project was just ending when we visited we thought that most of the proposal might already have been accomplished. We were most interested in discovering the relationship between the equipment and facilities to be purchased and specific undergraduate course offerings since that was not described in detail in the proposal. We wanted to know if students benefited from the increase in equipment and what the areas of specialization were for those students (i.e., majors or non-majors; entry-level or upper level undergraduates). The project management plan listed a steering committee and project director but did not note how equipment and facilities had been or would be chosen. The evaluation plan in the proposal specified assistance from a university center which specializes in evaluation. We were intrigued to see how well a project might be evaluated if a wealth of expertise were locally available.

Our major personal biases were similar and focused on one question--why would a large and resource-rich institution like Coastal University need to request funds from CAUSE for science education improvement? We found it difficult to believe that funds could not be found at the university to accomplish the same project and with much less effort than that required to get government funds.

Description of the Project

The activities of this project might be best thought of as aimed at the general goal of upgrading the science education resources of the Department of Geography. A steering committee of eight faculty members is responsible for the conduct of the CAUSE project. In practice, however, the steering committee has had very little to do. The project activities fall mainly in two categories: creation or improvement of laboratories and field sites; and redesign of companion laboratory and field courses. Needed equipment purchases were determined as part of the needs assessment process used in preparing the proposal. Redesign of labs and field courses necessitated by the changing and upgrading of equipment has been the responsibility of the instructors of the respective courses. The only decisions and activities which involved all the CAUSE faculty members and all the members of the department have been the assignments of new space for labs and the map room. However any problems caused by these moves were more outside the department than in since geography gained much new space from these moves.

The steering committee has met regularly if infrequently to discuss progress on the project, allocation of space, equipment purchases, and project evaluation. The project director has been responsible for negotiating access to additional rooms in order to create all the new labs. Some have been housed in Geography Department space which had to be remodeled. The project director also negotiated university funds to pay for the remodeling which cost about $31,000. Each faculty member was responsible for directing the specific arrangements for the lab in his area of specialization. For example, the lab technician worked directly with the instructor of biogeography and animal geography to create the aquaria system in the wet biogeography lab. The technician then worked with the project director to create the physical geography lab which is the project director's area of expertise. More detailed description of the new facilities and equipment is given below.

The wet biogeography laboratory is housed in a room which previously had been the wall-map library. The room had to be remodeled to accomodate its new function. As a wet lab, the laboratory contains an adjustable system of 30 aquaria on tables which make them easily viewable at eye level. The tanks can be connected with a flexible system of plastic tubing. Size and number of connecting tubes, temperature of the tanks, and living contents of the tanks, such as fish, snails and plants are all variables which may be manipulated by undergraduates participating in laboratory courses. Students run experiments in teams in order to study the dispersion behavior of natural organisms and to learn elements of observation, data collection and analysis. The lab is currently used by students in Animal Geography (75 students in winter, 1979) and Introduction to Biogeography (150+ in winter, 1980). The laboratory technician purchased the supplies (tanks, connecting tubes, temperature monitoring, pumps, filters, etc.) and constructed the aquaria system for about $500-600. Refurbishing of the room for the wet biolaboratory took about $2000.

Another CAUSE project activity has been to establish a permanent space for a remote-sensing laboratory. Project funds were used to purchase light tables, a contour plotter, magnifiers, a dual-view stereoscope, scales, planimeters, and mirror stereoscopes, and other supplies and equipment to create a complete facility for the analysis and interpretation of maps. Approximately $5000 of the project budget was used for the remote sensing laboratory. Another $3000 was expended to purchase aerial and satellite imagery. A new undergraduate course in remote sensing called The Earth from Above was initiated as a CAUSE project activity. The course is taught once or twice a year; up to 14 students can be enrolled in one offering. Most use of the lab is made by independent study students and students in other courses using remote sensing techniques for analysis and description. Assistants help to provide flexible access to the lab.

A physical geography laboratory has been established as a CAUSE project activity. A room which had originally been used for faculty offices was extended and enlarged to make space for the lab. The university contributed about $31,000 to refurbish the space acquired for new faculty offices and to renovate the space for the physical geography laboratory. These funds were not designated in the CAUSE proposal and had not been originally allocated for CAUSE project activities.

The flume is the most noticable device housed in the lab. The flume is a large tank made of steel beams with glass sidewall (see Figure 25). It is 10 meters long and 1.5 meters wide. It rests on concrete floorings, and a small staircase permits close-up viewing of water and sediment in motion. Water and sediment flow through the tank. Changing the volume of flow and the slope creates changes in the simulated fluvial system and wind-wave-current-tide sediment interaction. The laboratory technician designed and constructed the flume. Advice was sought from campus engineering department, from hydrology labs in government and universities, and from literature. The technician put together what

Physical Geography and Biogeography

The graduate program in geomorphology and hydrology emphasizes fluvial and coastal environments in temperate and arid lands. Studies focus on the relationship between the energy and materials involved on the one hand and the magnitude and organization of landforms and sediments on the other. Particular attention is given to human impacts on the nature and rate of erosion and sedimentation through such activities as agriculture, forestry, urbanization, and engineering projects. A subsidiary focus on the Quaternary Period emphasizes sea-level changes, tectonism, glaciation, and related geodynamic responses.

UPPER DIVISION UNDERGRADUATE COURSES

102	Geomorphology
104	Climatology
105	Hydrology
106	Soils
108	World Vegetation
109	Ecology of Vegetation
110	Plant Migration
112	Animal Geography Biophysical Aspects
114	Physical Bases of Geography
116	Origins and Histories of Crop Plants
117	Animal Geography: Cultural Aspects
118	Medical Geography
119	Agricultural and Pastoral Ecosystems
120	Conservation of Resources: North America
121	Conservation of Resources: Underdeveloped World
122	Man and Environment in Africa
124	Environmental Impact Analysis
125	Marine Ecosystems
127	Soil, Plants and Society
128	The World's Ecosystems: Problems and Issues
129	Problems of the Environment: Seminar

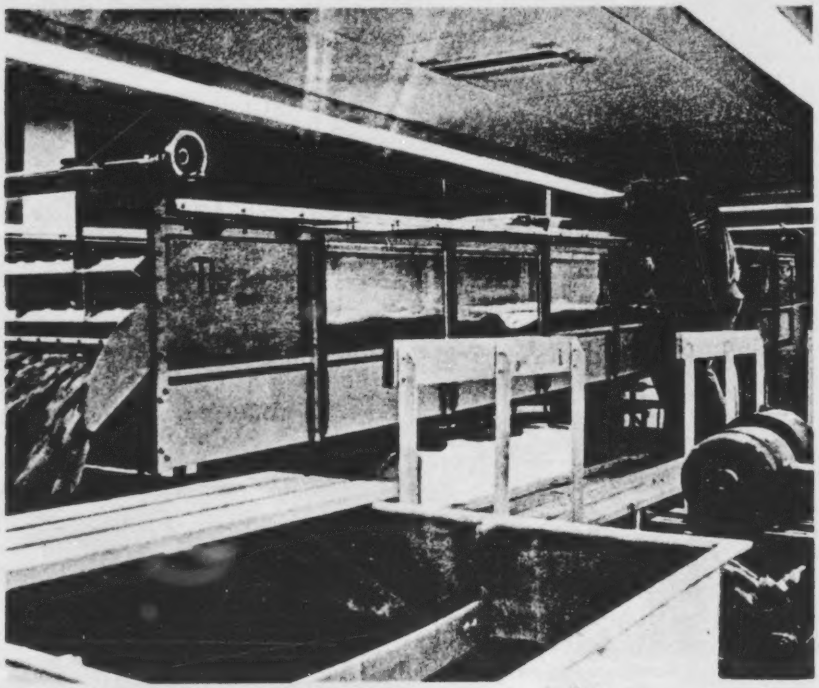

Figure 25.

The flume at Coastal University built with CAUSE funds is shown in the photo on the left.

he thought was the best from the different sources and his own ideas (baffles to help settle out sand for return flow). He purchased or found all the parts to construct the flume and managed to get cooperation and assistance on campus from the physical plant office and the construction laboratory of the engineering school. The completed flume was cheaper and is more flexible to use than those available commercially.

Several other pieces of apparatus housed in the physical lab have been purchased or constructed using CAUSE funds. These include a small flume for water flow only; a 2x2 meter sediment tank with a recirculating hydraulic and sediment system for demonstrating alluvial fans, deltas, and littoral drifts; and instruments for mechanical analysis of sediments and soils. Laboratory manuals for use of some of the physical laboratory equipment have been developed with CAUSE funds by graduate research and teaching assistants.

The proposal for this project describes the creation of field sites and the purchase of equipment to be used in the field as a project activity. Eight sites are to be developed. They are located on land which belongs to the state university system and which represents a range of geographical phenomena. The instructor of the course, Field and Laboratory Analysis: Biogeography, coordinates the Department of Geography's use of these sites. Many of the faculty members make use of the sites in their courses. For example the instructor who coordinates the sites has students in Plant Ecology conducting various studies of vegetation cover and local plant species. The instructor of the courses in climatology has had some of his students studying climates at different elevations at one of the field sites. CAUSE funds have been used to purchase a variety of equipment and supplies for field studies which include telescopic levels, soil moisture meters, altimeters, rain gauges, flowmeters, tripods, survey tapes and rods, and other materials.

Overall the outcomes of this CAUSE project are additions of equipment and facilities to the department. Undergraduate research projects have been added or increased in a variety of environmental studies courses. Since project activities have been primarily ones of selecting and purchasing equipment or furnishing new laboratory facilities, continuation costs to the university once the project is finished are likely to be low. Upkeep of the laboratories and use of the field sites will have to be funded from the department budget.

Issues

Institutional needs. Given the size of Coastal University's physical plant and its obvious richness of resources we found it difficult to believe that any academic department would want for any instructional resources. Yet the project director, the department chairperson, and the CAUSE faculty members were adamant in their opinion that money for capital purchases and physical plant renovations is not available from the university. Many of the resources at the university have been acquired only because the faculty have attracted federal government and private grant support to provide them. The current policy of the state is that Coastal University is a steady-state operation. There is to be no net increase in student enrollments. Any shifts in enrollment and budget allocations must be internal to the university. Therefore, without CAUSE funds the Department of Geography could only have acquired a small portion of the equipment which they now have because of CAUSE. It is likely that new laboratories and research equipment would never have been established or purchased if only university funds had been available to the Department of Geography.

Project implementation. Given that the focus of this project has been primarily on acquisition of equipment and laboratories, project implementation seems straightforward. Very little actual cooperation among department faculty was necessary in order for the project to be successfully completed. The project director did a remarkable job in negotiating the reallocation of space to the department and the funds for remodeling. These funds were not originally promised in the proposal as a university contribution. These acquisition tasks were probably made easier by the project director's appointment as Dean of Social Sciences.

An interesting question is raised by this successful internal politicking and that is: How could the objectives of the CAUSE project have been accomplished without the extra space and dollars? We assume that the project director knew at the time of proposal preparation that extra space and money from the university would be necessary, although we did not question this or understand its importance until after the site visit was over. It seems obvious to us now that extra resources are easier to acquire from a university if a federal agency like NSF has promised to fund the purchase of new laboratory equipment. The successful manipulation of university politics seems to us to have enhanced the implementation and the impact of this project.

Another interesting thing we noticed about project implementation is a series of steps taken by the project director to spread the project dollars as far as possible. The original proposal called for acquisition of lab and field equipment to be prorated across the full three years of the project, according to CAUSE guidelines. The project director initiated conversations and special requests with the CAUSE program office to get permission to purchase as much equipment as possible during the first year. He undertook this approach to project implementation in order to avoid 10-15% yearly cost increases in equipment predicted by equipment manufacturers.

Quality of instruction. This project has had a major impact on the Department of Geography resources. As discussed above in the section on institutional need, apparently the impact on research and analysis facilities for undergraduates could only have come from outside funds.

Faculty members are likely to have felt the greatest impact of this project. About one-third of the faculty of the department have changed courses to include use of the new equipment and facilities. Several new courses have been added, as well as various field and laboratory components added to existing courses. Other courses have been substantially revised and the undergraduate program in both majors has been modified.

One major impact on the department has been the establishment of a lab technician position with CAUSE funds. The university has agreed to pick up support of this position once CAUSE money is gone and to continue to provide that position to the Department of Geography. This position did not exist prior to CAUSE.

Impact on students is clearly the most difficult to assess. We did not make an opportunity to interview any undergraduate students. Two graduate students declared that their undergraduate education in geography would have been much improved by courses which included the kind of lab experiments available with CAUSE-funded equipment. Most of the students who will utilize the equipment will be majors enrolled in upper division courses.

One instructor shared some student evaluation data from his course, Animal Geography: Biophysical Aspects, with us. In this course students had to conduct as part of a team an experiment utilizing the aquaria. Then each had to prepare an experiment report including observations and data analysis. Students' evaluations of this course were very interesting. Most students could be put in one of two groups. The first group consisted of those who found the course too demanding and requiring too much work. Some sounded frustrated, others quite put out by the course requirements. The second group of students represented the opposite point of view. They were thrilled by the experiment and the opportunity to try computer analysis of data. Some of these students noted that the course required a lot of work but were not put out by it. Clearly the impact of adding a laboratory experience to that course has had an impact on students!

Project evaluation. We noted two evaluation activities on this project. CAUSE project faculty members have been collecting and analyzing student reactions in order to fine tune the courses which have been changed or revised with the addition of laboratory and field components. The second activity was an expert review conducted by the chairman of another prominent department of geography. He visited Coastal for two days during the second year of the project. His evaluation is very positive and supportive of the improvements made with CAUSE funds. Staff from the evaluation center on campus were not consulted with respect to project evaluation as was suggested in the project proposal.

Summary

There are several notable aspects of the CAUSE project at Coastal University. The project director used the CAUSE grant as leverage to get additional space allocated to the Department of Geography and additional university funds for renovations. The faculty worked carefully with the lab technician to create exactly the kind of lab facilities that they wanted for their students. The lab technician did an outstanding job of designing and building the equipment to meet the Department's specification.

Elms College

General Background

Focus:	Reform of freshman biological science laboratory courses
Budget:	From NSF: $141,600 From Institution: $ 44,005
Began:	1976
Duration:	36 months
Date of Visit:	February 28-29, 1980
Visitors and Report Authors:	Esther Lee Davenport and John D. Eggert

Elms College of Arts and Sciences, part of the state university system, is an urban commuter college. Its approximately 4,000 students come from what the proposal describes as "a problem plagued city". Their backgrounds are diverse--many are educationally disadvantaged, others have strong academic skills but do not have the financial means to attend a residential college. The college is associated with the University College of the state university system, and shares its facilities and staff with it. The University College serves primarily night school students who also hold down full-time jobs.

The CAUSE project at Elms College was directed at the ameliorization of two problems identified in the proposal: student needs which traditionally-trained science faculty and traditional forms of science teaching could not meet, and lack of student motivation in science due in part to the predominance of lectures as the course delivery method and to what was described as the "impersonal atmosphere" of the college. More specifically, the project was aimed at improving two freshman biological science courses, General Biology 101-102 (enrolling 600-700 students per year) and Zoology Core 103 (enrolling 80-120 students per year). Eighty percent of students at the college take one of these two courses sometime during their college careers.

The objectives of the project (we gleaned from various sections of the CAUSE proposal) were to:

- account for individual student differences in intellectual and emotional needs;
- foster analytical and critical thinking;
- expose students to faculty schooled in current educational theory and practice;
- enhance student self-confidence and personal creativity;
- provide personal attention, counseling, and supportive guidance; and
- direct subject matter to student professional needs and life interests.

To meet these objectives, project plans called for the implementation of an audio-tutorial approach to instruction. Project activities were to include the development or improvement of self-paced study and testing materials, provision of essential laboratory equipment and supplies, and construction of a Learning and Resource Center in which these materials could be used.

Information on the Site Visit

Our general strategy during the conduct of the two-day visit to the project was to first determine how the particular approach to audio-tutorial instruction at Elms College was being implemented. We also sought to discover the degree to which the project met actual institutional needs and the likelihood that the project would be continued after the termination of CAUSE funds. In addition, we were interested in determining the project's impact on students (as perceived by faculty and students); the types of evidence which were being used to assess project impact: what strategies and techniques had been used in initiating project activities and in keeping them operational; and how the project objectives relating to the encouragement of creativity, values clarification and self-confidence were actually being operationalized.

In seeking understanding of these aspects of the project we interviewed faculty, administrators and students in order to gain varying perspectives on issues of concern. Especially, we held discussions with the following:

- -Course director (and developer) of General Biology 101, and Associate Professor of Botany;
- -Course director (and developer) of General Biology 102, and Assistant Professor of Zoology;
- -Associate Professor of Zoology, developer of the new Zoology Core 103;
- -Manager of the Learning and Resource Center;
- -Chairman of the Botany Department;
- -Associate Dean of the University College;
- -Assistant Dean of the College of Arts and Sciences; and
- -Approximately eight student users of the Learning and Resource Center.

The person formally named project director was not available at the time of the visit. This was not a serious problem for us since the course developers, particularly the course director of General Biology 101, actually directed the project. In addition to our interviews both with individuals who were closely associated with the project and some who were only peripherally involved in or impacted by project activities, we examined the tangible outcomes of the project. Specifically, we toured the Learning and

Resource Center which had been established, observed its use by students, reviewed instructional materials developed, and reviewed the results of project evaluation activities.

Project Description

The main focus of the project was the development of three large courses: a two-course introductory sequence to General Biology and Zoology Core 103 (the course taken by most zoology majors as an introduction to Biology). All three of these courses existed previously but were felt to be in need of complete redevelopment. The Biology faculty felt the traditionally taught two-course sequence was not meeting well the diversified needs of the biology students. The laboratory portion of the course was seen as particularly inadequate due to limited facilities and the large numbers of students using them. The zoology faculty felt the biology sequence was being watered down too much, the main reason the separate Zoology Core 103 course was originally developed. The zoology faculty also felt, however, that the Core 103 course needed to emphasize problem solving skills of freshmen zoology majors, and needed to provide an "unthreatening atmosphere in which students will risk making mistakes, ...learn how to learn, build self confidence and independence from teachers and discover the excitement of learning."

In spite of the fact that each of the three courses existed previously, the project is more appropriately thought of as a course development project than merely a course improvement project. The activities related to the biology sequence involved the development of a completely new audio-tutorial system, including the design and construction of a Learning and Resource Center, the development of a set of laboratory exercises to support weekly audio-tutorial laboratory sessions, and the design and implementation of the support systems necessary to the success of an audio-tutorial course (e.g., advising services, student manuals, equipment and supplies checkout procedures, monitoring and testing, etc.). The activities related to the Zoology Core 103 involved a greatly increased emphasis on "humanizing and individualizing" the course partially through the use of student discussions, programmed study guides, and computer-based post-testing, none of which had been developed at the beginning of the grant period.

The activities of each of the courses relied heavily on the Resource and Learning Center which provided a place for student and staff interaction as well as the facilities necessary to support the audio-tutorial exercises.

Biology 101-102. The primary impetus behind the design and implementation of the audio-tutorial two-course sequence was the Director of Biology. ("Course Director" is the title given to the person responsible for the overall coordination and management of large courses at Elms College). He also was the sole designer of the Biology 101 course. For this reason, it is important to understand this aspect of the project in terms of the Director of Biology's relationship to it. The Biology Director radiates enthusiasm about the value of the CAUSE project in the education of prospective majors in botany and zoology. He gives the impression of being a very active, very busy and very organized person. He is presently teaching more than the normal course load. The back of his office door is cluttered with 15 to 20 messages that he posts outside his office every time he leaves: "Closed until 3:30 today", "Will return at 12:40 p.m.", "The Director is next door in Room 111", etc. He is aware of the enthusiasm he projects and feels it is an essential part of teaching. "The attitude is so important--if the faculty aren't excited then the students won't be either."

A good deal of the Director's time is spent in the learning lab over and above his regular teaching duties. We learned that the various materials used in the lab were under a constant state of revision and informal testing. "When I make changes in the manual I go up to the lab (usually in the summer) and see how they work.... I watch the students very carefully."

The Director has been at Elms College since 1972. Shortly after arriving, he was given responsibility for coordinating the first semester Biology 101 course--a course which serves approximately 800 students annually. This position meant responsibility for teaching lectures and laboratories, supervising teaching assistants, grading papers and tests and directing student registration.

In that period, Biology 101-102 was taught in traditional ways involving scheduling of twenty lab periods a week for four lecture sections. Two faculty were involved as were twenty teaching assistants. Since the construction of the Learning and Resource Center an audio-tutorial self-paced approach to laboratory exercises has been taken, using the Center carrels and equipment; however, students are still strongly encouraged to attend lecture sessions. Students have access to the Learning and Resource Center and teaching assistants help there for more than 45 hours a week (including two evenings). Students also are involved in at least one (of 38 available) discussion section a week, in which groups of approximately 20 students meet with a T.A. to consider the current laboratory topics in a setting which encourages questions on the part of the student. Students are evaluated by four lab tests and three course-wide tests. Records of attendance are kept as a means of early identification of problem students. Mini-courses (labs) are available for one week only, except under extraordinary circumstances. These procedures require no more faculty or teaching assistants, but do require staff to manage the Learning and Resource Center. "I don't believe in leaving the students alone in the lab," explained the Course Director, "I have a minimum of two to three TAs in the lab every single hour it is open." It is clear that the Director also spends a good deal of his own time in the lab, observing, inquiring, and helping out students.

The first summer of the grant, in 1976, the Center was constructed and a set of audio-tutorial mini-courses based on work done at another university was purchased. Students reacted negatively to these (primarily because of the length of the tape presentations--about an hour per mini-course), and the Director began to develop his own mini-courses and tapes. These were tested during a summer session with a "small" class of about 60 students. Testing included getting student and teaching assistant opinions, observing the accuracy with which students were able to follow directions, and checking to see if students obtained the results expected in the laboratory exercises. By the 1977-78 academic year, the first version of his 13-unit study guide for Biology 101 with supporting tapes was ready. It has since been revised significantly, based on feedback (primarily informal) from staff and students. The tapes now average 15-20 minutes in length, with more of the content in the manual rather than on the tapes. The tapes are used for orientation to the lab and for providing directions for the laboratory procedures. The tapes and the manuals are structured so that the only way the exercises can be correctly completed is through the actual performance of the prescribed activities.

The development of the second half of the Biology 101-102 sequence was done by an assistant professor of Zoology who was also the Course Director of Biology 102. The development process paralleled that used in Biology 101 except that less time in general was devoted to the project. Less emphasis was placed in field-testing and revision of materials, and the materials were developed at a slower rate. This is not a reflection on the developer of Biology 102, but rather an indication of the substantial amount of time that is required to develop a course of this nature. The assistant professor reported, as did others, that he spent well over the two summer sessions allocated to course development and that to have put in additional hours to observe students and revise modules would have meant sacrificing his research and publication record and thus his upcoming promotion. Based on available information, it appeared that the Biology 102 segment was functioning as well as the Biology 101. This was apparently due to the fact that the Biology 101 mini-courses served the purpose of field-testing many of the audio-tutorial approaches which were then used in the second course of the sequence.

The Learning and Resource Center. The Learning and Resource Center consists of approximately 5,000 square feet of space divided into a number of partitions. About one-third of the space is devoted to a library space formed by several movable partitions, a discussion room separated from the library with a soundproof window wall (used for taping of teaching assistants' presentations), and a snack area. The remaining two-thirds of the space is the area used for the audio-tutorial laboratory activities.

It is equipped with 60 carrels (each with its own audiotape player) and lab facilities. Color slides, 8mm film loops, filmstrips, 16mm film, videotape and interactive computer capabilities are also available to support activities of the three new courses as well as other life science courses.

The facility is managed by a full-time manager who had been a graduate student in biology. His enthusiasm for his responsibilities was obvious. He works long hours at close to the minimum wage. The Center manager appeared eager to show us around the lab and to introduce us to TAs and students. He was proud of his apparently well-organized and efficiently-run facility, and it appeared that he had a right to be proud of it. It was an inviting facility--aesthetically pleasing and conducive to study.

Zoology Core 103. The change in status of the Core 103 course over the duration of the CAUSE project is interesting. Initially, before the start of the project, Core 103 was used by zoology faculty as the introductory biology course for zoology majors because it was felt that the Biology 101-102 sequence was inadequate. (This is acknowledged by biology and zoology faculty alike.) The intention at the start of the project was to improve the Core 103 course even more through the development of materials and activities which would enhance the students' problem-solving abilities and help them to become more independent learners and thinkers. However, the success of the Biology 101-102 course sequence was such that the zoology faculty felt it to be superior to the old Core 103 and substituted the Core 103 course with the Biology 101-102 sequence. At the same time, the developer of Core 103 found it impossible to complete all of his course development goals, facing at the same time constraints the other developers ran up against in addition to the difficulties posed by developing an individualized, self-paced freshman level course focused on the increase of higher order cognitive skills. Thus, although many materials have already been produced, the course has been discontinued by the Zoology Department.

Issues

Institutional needs. Elms College has a student body which commutes and which includes many students who have trouble reading as well as some very good students. There is clearly a need to provide instruction appropriate for a diversity of learning rates. Further, basic needs for laboratory equipment and supplies, instructional development time, and audiovisual equipment were unmet. State funding for the college has not been adequate, according to the proposal and the project staff. Thus, provision for self-paced learning in an audio-tutorial format, and the provision of the above-named basics--which are the essentials of this CAUSE project--can be said to clearly meet institutional and educational needs. Confirmation of this statement was obtained in interviews with faculty and administration. The inadequacies of general biology had been complained about in the student newspaper, complaints had been received from the medical college about student preparation, and zoology had even developed its own basic biology course because the general biology was inadequate.

Further confirmation of the need for the project is the degree to which it has been integrated into the functioning of the college. Support for the Learning and Resource Center has been established at an effective level. The Center's condition after three and one-half years appears very good. Even the fact that the physical reconstruction necessary was carried out in such a timely manner (all renovations were completed before the first fall session of the project) suggests the project met a real need.

Finally, it can be said that CAUSE funds were probably necessary to implement both the curriculum change and the physical renovation, as institutional budgets are strained. The generally spartan physical environment at the college and the heavy teaching loads of faculty further support this observation.

Implementation. The objectives of the project focused primarily on the redesign of three courses: Biology 101 and 102, and Zoology Core 103. (Biology 101-102 was often referred to by project staff as if it were a single course, but, in fact, it operated as a two-course sequence in Introductory Biology.) The nature of the implementation of each of these courses varied substantially. Biology 101, which relied heavily on the audio-tutorial approach, appears to have been extremely successfully implemented. An entire set of materials and exercises has been designed, field-tested, and many individual exercises have been redesigned, field-tested again and sometimes refined yet another time. While Biology 101 was obviously the most extensively implemented of the three courses, this was apparently only possible because of the many extra hours put in by the project director far beyond the two summer sessions allocated to the project. The materials and exercises for Biology 102 were less completely developed and less extensively field-tested because, its developer reported, the time allotted for the task (also two summer sessions) was simply not sufficient. The Zoology Core 103 course was partially designed and developed. Although the extensive printed materials prepared by its developer attest to the large amounts of time devoted to the project's development, their overall organization and quality clearly revealed deficiencies in the development process. It seemed clear to the site visitors that the materials would not be very useful as they presently exist, even as supplementary materials. The fact that this course is not presently being used further substantiates this observation.

The most important success of this project is undoubtedly the development and institutionalization of the Learning Center. The physical facilities were erected in a matter of weeks, and the efficient development of course materials for Biology 101 and 102 allowed for the full-scale implementation of the Center early in the life of the project. An efficient and practical audio-tutorial system, complete with a variety of student support services, has been established, is functioning efficiently and will probably continue to function. The success of the project seems to be due to several (probably interrelated) factors:

1) A remarkably enthusiastic and talented staff--a group including both faculty and staff who seem devoted, even at some risk to their normal career progress, to student learning and motivation;
2) an evidently strong need for the physical and curriculum improvements carried out in the project;
3) good communication with and support from influential college administration;
4) pre-implementation visits to other colleges trying similar efforts; and
5) close attention to details of course operation--records, care of supplies, maintenance, test quality, training of TAs.

Constraints on project implementation included some that were primarily attitudinal in nature, and others of a more concrete type. These were apparently largely overcome by the positive factors listed above.

Constraints included:

1) strongly negative attitudes toward the changes made on the part of a few influential senior faculty;
2) differences in educational philosophy and a history of poor communication between the Botany and Zoology Departments;
3) lack of institutional incentives for devotion of time and energy to improvement of instruction. Tenure is increasingly difficult to attain, and activity on a project of this kind carries little weight in decisions about tenure. Three of the involved faculty have faced this problem during the period since the project began.
4) insufficient faculty time for course development. In order to be competitive, writers of the proposal short-changed themselves on development time. It seems clear that the primary reason the project was a success was that those few individuals most directly involved were willing to put in large amounts of their personal time over and above their regular duties.

Quality of instruction. By all subjective impressions, this project has provided substantial improvement in instruction. Faculty, administrators, and students interviewed seemed sincerely enthusiastic about the changes made. The replacing of both the previous Core 103 and evening instruction in general biology with the new course in general biology seems to be strong evidence of a positive impact. The several observations we made of the Learning and Resource Center at various times of the day also provided a strong impression of an effectively functioning resource. We saw Admissions Office personnel showing the facility to prospects; we sat in on a relatively well-run coaching/discussion session, attended by a sizable group of attentive students; we observed orderly use of the carrels. The physical environment is strikingly attractive and seems well-designed for flexibility of use. Two students unprompted by any question from the visitors volunteered that the faculty and staff involved in General Biology make students feel cared about, even "loved".

Probability of continuation appears high. The college has so far funded the essential position of learning center manager, provided for sufficient student assistants, and funded a part-time secretary. Much needed upgrading of salary for the manager position is apparently underway. The integration of the new format general biology course into current functioning and into long range plans of the evening school, University College, also supports the idea of a good probability of continuation. The paucity of funding which was a partial source of the need for the project is always a threat, but the signs at present are positive.

Evaluation processes. A variety of evaluation procedures were proposed:

1. Questionnaire to determine "cognitive and affective needs" prior to each course.
2. Number of students attending General Assembly and using Resource Center library.
3. Post-tests at end of each mini-course.
4. Monthly program evaluation questionnaires, including measures of "affective learning".
5. T.A. evaluations of student discussion and essays.
6. Follow-up questionnaire two years after the course.

Responses to mini-course post-tests and to evaluation questionnaires were to be computer-scored and summarized on a regular basis. No attempt to compare results with comparable results prior to the change in method was proposed, nor were specific plans for analysis of the other data listed.

For the most part, these plans were not formally realized. A variety of questionnaires were administered, most frequently during the first year.

Data from some of these were computer analyzed, but there appeared to be little relationship between results of these analyses and actions taken. Some of the analyses of the data, particularly related to Zoology Core 103, were clearly inappropriate and were used to support erroneous conclusions about the data.

It would not be accurate to say that no useful evaluation occurred, however, particularly with respect to formative evaluation efforts to improve the design and implementation of the three courses and the overall audio-tutorial approach. The project director reported, and students and faculty confirmed, that he spent hours observing students work through the materials, taking notes on required changes as he observed the need. Other faculty did the same, although apparently to a lesser degree. In addition to information collected through observation, student comments were solicited through suggestion boxes and irregularly collected end-of-course forms.

The project director reported making several major revisions in the materials, and numerous minor changes, based on this informal data. For example, commercially prepared tapes and mini-courses were replaced with locally made units on the basis of student objections. The faculty-developed mini-courses have been modified. The device called the "T.A.--OK" was introduced to give students a check on certain lab activities. Involved faculty and staff have received much positive reaction from students and administration; and there seems little interest in more structured evaluations.

Summary

The Elms College CAUSE project provides an outstanding example of the design and implementation of a two-course audio-tutorial laboratory sequence and the supporting physical facilities and course management systems. Its success is due to a substantial degree to the dedication of the project staff, particularly the course director of Biology 101. In spite of the underestimation of faculty time necessary to carry out a project of this magnitude, the staff devoted hundreds of additional hours to create a comfortable, efficient and apparently effective audio-tutorial biology sequence.

Hilltop University

General Background

Focus:	The upgrading of an electrical engineering department's capabilities in the area of computer principles and applications through faculty, course and facilities development
Budget:	From NSF: $143,378 From Institution: $71,690
Began:	1978
Duration:	36 months
Date of Visit:	November 12-13, 1979
Visitor and Report Author:	Spencer Swinton and John D. Eggert

Hilltop University is a private urban Jesuit university. Traditionally strongly committed to teaching, its focus has expanded to include a greater emphasis on excellence in research, and on attracting external research support in response to the changing conditions of higher education. The Department of Electrical Engineering has maintained its focus on teaching, maintaining close liaison with local firms which employ electrical engineers. This collaboration has been marked by departmental responsiveness to employer needs resulting in increasing enrollments and high percentages of placement of graduates in area electrical engineering positions.

Consistent with this responsiveness to industry needs, the department has recognized the growing significance of mini- and microcomputer applications for all of its undergraduates -- not only those desiring to specialize in digital circuit design. A 1975-77 National Science

Foundation Instructional Scientific Equipment Program (ISEP) grant, under the direction of the present CAUSE project director, made possible the development of a small laboratory facility for hands-on educational and research experience in microcomputer uses and interfaces.

In 1976, two years before the start of the CAUSE project, a departmental committee on Goals, Planning and Implementation, under the chairmanship of the present project director, began work. Its May 1977 report recommended that the department concentrate attention in a limited number of areas -- energy, control, bio-electrical engineering, and small computer technology, and focus on development of strength in these areas. Based on this report, a proposal to the NSF CAUSE program was submitted in November 1977. The purpose of the proposed project was to strengthen the mini- and microcomputer component of the program, building on the activities and decisions already undertaken. The proposed objectives for carrying forward this effort were threefold:

- Course development, both in areas specifically concerned with small computers, and in incorporating principles and applications of small computers "throughout the electrical engineering curriculum at Hilltop University." Increased faculty awareness and knowledge of the area was expected to be reflected in changes in course content and sequence. Computer applications were anticipated in a wide variety of courses, including those in the other central areas of departmental focus.

- Facilities development, particularly in the area of expanded computer graphics capabilities to support new applications, including an Intel MDS 800 microcomputer, two Tektronix 465 scopes, a CRT for the microcomputer system, and additional graphics and memory capability for the existing PDP 11 computer.

- Faculty development is a key strategy in the project. Without expanded awareness of, and interest in small computers throughout the department, course revision and new equipment utilization could be expected to be restricted to faculty members and courses already centrally involved with small computers.

Information on the Site Visit

Our site visit was conducted in November of the second year of the project, about one full year into the action phase of the project. We interviewed the principal and more peripheral actors in the project, reviewed relevant project documents, and toured facilities.

Our primary purpose was to gather evidence concerning the actual implementation of proposed activities during the first half of the project. We paid particular attention to faculty involvement because of its key role as both an end and a means in the project design. We examined the structure of the implementation, including management, timetable, and barriers encountered, and particularly the integration of the visiting faculty member's role with ongoing departmental activities. We assessed the impact on instruction to date and, more importantly, the potential for continuing instructional improvement resulting from the project. We sought evidence of project use of evaluation data. Overall, we emphasized the question of the extent to which each component activity related to the overall goals of the project and of the department. We interviewed the following persons during the course of the visit:

- The Project Director, Associate Professor of Electrical Engineering;
- Three professors of Electrical Engineering who participated heavily in the faculty development aspects of the project;
- A visiting professor of electrical engineering who provided the project with technical expertise in computer graphics;
- Chairman of the Electrical Engineering Department;
- Other electrical engineering faculty who participated in faculty development projects;
- The Vice President for Academic Affairs;

-The Director of the Office of Research Support; and

-The Dean of the College of Engineering.

In addition, the principal faculty involved in the project gave a formal two-hour presentation on the project for the site visit team.

Description of the Project

The project can be described in terms of five components: course development, facilities development, faculty development, computer graphics activities, and project evaluation. Each of these components is meant to address specific needs.

Needs. The growth of enrollment in the introductory microcomputer software course, ELEN 190, illustrates the increasing importance of microcomputers in the department. First offered as a senior elective in Fall, 1974, the course drew 35 students. In successive fall semesters, enrollment was restricted because of lack of equipment. Twenty-four students took the course in the summer, 1978, and an additional 58 in the fall semester. for a total enrollment of 82. In the spring semester of 1979, as part of the CAUSE program, the course was offered as a junior elective to make possible an entire senior year of more advanced work. The course was fully subscribed with 70 students. An additional 24 in the summer and 42 in the fall brought the 1979 total to 136, a 66% increase from the 1978 total.

More advanced computer electives showed similar enrollment pressures. In 1978, 43 students took ELEN 191, the microcomputer hardware lecture course, but there was room for only 15 in the microcomputer software lab course. In 1979, 53 students took the lecture course, but 41 were able to take either the lab or the newly-offered advanced microcomputer systems or Computer Graphics Applications courses. This last course accounted for over 60% of the enrollment increase and was a direct result of the CAUSE project in that it was taught by the visiting faculty member funded by the program.

Course development. The purpose of the new course offerings was not merely to expand enrollment, but to add flexibility. When the project is fully implemented, students will have the option of a two-course sequence: the introductory lecture course followed by the software lab; or, a more intensive three-semester sequence consisting of ELEN 190, 191, and a newly-developed Microcomputer Applications lecture/lab, offered concurrently with the software laboratory course in the final undergraduate semester. This applications course was developed as a part of the CAUSE project.

Facilities development. Facilities development included purchasing new hardware and interfaces, and developing new software. The thrust of facilities development was twofold -- first, to strengthen and expand the microprocessor laboratory facilities initiated under the earlier ISEP project; second, to develop computer graphics facilities linked to the department's PDP 11 minicomputer, and to the university's Xerox Sigma-9 time-sharing facility. New laboratory equipment requested included an Intel MDS 800 microcomputer system, oscilloscopes, a CRT for a microprocessor system, and $3500 in expendable laboratory supplies. A student assistant to assist in software development for the expansion of the ISEP-initiated laboratory course was also supported by CAUSE funds in this component.

The graphics equipment requested included additional memory and a hard disk capability to expand the PDP 11 for student and instructional use, a graphics terminal (Tektronix 4013), an audiovisual monitor, and $2400 for audio-visual supplies. Fifteen hundred dollars for the time of an instructional media consultant was contributed by the university in addition to the one-eight time of the evaluation coordinator and all indirect costs for the project. The proposed instructional uses centered on the development of computer-generated teaching aids for course enrichment.

Faculty development. A senior member of the engineering faculty has been a key actor in the activities of the project. Not directly funded by CAUSE, his activities have been motivated by growing interest in microcomputers. He developed an intensive seminar in the first semester of CAUSE activities, and presented it to Electrical Engineering faculty beginning January 30, 1979 and ending in March with hands-on small computer applications experience, provided by placing the INTEL Prompt 80/85 in each attendee's office for a period of time. Attendance at this quite rigorous short course was high. At the same time, the continuing Department Colloquium became an adjunct to the Small Computers Applications seminar, with speakers from industry and from other universities discussing instrumentation, control, computer assisted instruction, graphics and design applications of microcomputers.

A newsletter, designed to increase awareness of faculty and other interested parties about CAUSE activities, related speakers, conventions, displays, and the rapid pace of innovation in the microprocessor field, was circulated beginning in February, 1979. Four issues appeared through April 24, and the newsletter was published monthly beginning in September, 1979. The newsletter was circulated widely and generated considerable interest on the campus and in the surrounding professional community.

Support for faculty attendance at conferences, workshops, and short courses and for industrial site visits was an integral part of the staff development program. As would be expected, the core group of faculty most involved with small computers was central in these activities, including INTEL workshops, computer science conferences, and tutorials on computer graphics. Other faculty members who were most important targets of this component did, in fact, also take advantage of these opportunities, were supported, and came back with new ideas for applications of small computers in their areas of interest.

In the fall 1979 semester, a university-wide small computer applications seminar was expanded. Although this expansion had not been envisioned in the original proposal, the activities of the spring semester had engendered sufficient interest to justify expanding the scope of the course rather than merely repeating it for new faculty members. The senior faculty member brought in colleagues from the department to assist in conducting the seminar. Some fifty faculty members from disciplines ranging from chemistry to the campus ministry attended the six sessions in October and November. Topics covered included an introduction of the microcomputer, IO devices, software, applications, other small computers, and hands-on experience.

Finally, the faculty development program included support for printed resources and undergraduate assistants for faculty members who wished to begin using microprocessor technology in instrumentation and control in their own areas of research -- energy, biomedical applications and others. This approach has been implemented in only a few cases.

Computer graphics. A visiting professor, funded by the CAUSE project, was responsible for the computer graphics component of the project. The visiting professor's responsibilities included offering a computer graphics undergraduate course, developing exemplary graphic teaching aids, and introducing faculty to the potential of, and techniques for, producing such aids for particular teaching applications.

The undergraduate course utilizes Tektronix commands and sub-routines developed by the instructor to enable the student to graph geometric component shapes and schematic symbols. Then each student is asked to develop a graphical teaching aid, documented with comments. Suggested areas for teaching aids included Fourier expansions, pole-zero plots, three-phase systems, steady state circuit analysis, and convolution. A list of faculty and their interests was provided to the students.

Other activities in the fall semester had included computer graphics presentations to the IEEE Student Branch, the Dean's Engineering Advisory Council, the Electrical Engineering Colloquium series (in addition to a presentation in March), an EE Department meeting presentation, and the university-wide small computer applications faculty seminar.

Evaluation. Evaluation occurs on the project through the joint efforts of a five-member faculty committee and an evaluation board consisting of representatives of three local corporations and a computer science faculty member of another university. The joint responsibilities of the two committees are to evaluate progress towards objectives, to identify alternative activities as necessary, to advise the project director and the department chairman and to evolve a department-wide evaluation process. The present evaluation process consists of a series of formal two-day site visits by the evaluation board during which time materials and facilities are reviewed, interviews are conducted and formal discussions are held. The faculty committee is involved in similar activities on a less formal basis. In addition, base-line data has been collected and continues to be collected on student and faculty perceptions of mini- and microcomputer use in the curriculum. Present plans are for the evaluation process to continue at least several years past the grant expiration.

Issues

Institutional need. It is clear that the need to upgrade facilities, courses and faculty expertise in the area of mini- and microcomputers is a real and legitimate need at Hilltop University. It represents an institutional commitment formally established several years prior to the grant and supported by the university, the college and the department. The commitment of the Electrical Engineering Department faculty, those supported by the project as well as those not supported, and of the faculty who became involved with the faculty development activities gives further evidence of the reality of the needs addressed by the project.

There does seem to be a tension between the university's commitment to the improvement of instruction and its commitment to research. The department chairman questioned the professional payoff for the project director's participation in the CAUSE grant. He echoed the suggestion we heard from several quarters: that CAUSE grants might be restricted to full professors. The project director, although given a national award as Outstanding Electrical Engineering Teacher of 1979 by Eta Kappa Nu, was directing a teaching, rather than a research project, and there was concern that this was not worth as many "points" as would be equal effort devoted to a hard research project. This impression was confirmed in meetings with the Vice President for Academic Affairs, the Director of the Office of Research Support, and the Dean of the College of Engineering. As with many small private institutions, survival increasingly depends on attracting external research support.

Instructional improvement may become more important as competition for students makes ratings of instructional effectiveness an increasing factor in how students choose colleges. Currently, it would appear that in fairness to junior faculty, instructional improvement should be left to those who have climbed the academic ladder. However, such individuals may not be interested. In cases like Hilltop, where teaching is genuinely valued, an uneasiness about diverting junior faculty into instructional improvement activities represents a recognition of the ambivalence of the smaller university's role. (It should be noted that in spite of the uneasiness expressed about the professional value to the project director of participating in the CAUSE grant, he was subsequently granted a promotion by the College of Engineering.)

Implementation. The project has been implemented as planned. Equipment has been procured and new courses have been developed. The aspect of the project given most emphasis in the proposal, that of faculty development, has been particularly successfully implemented. The new equipment is being heavily used for instructional purposes; engineering faculty are introducing mini- and microcomputing concepts into their other engineering courses;and, most importantly, the faculty development seminars are being unusually well attended and a demand for them continues.

The success of the faculty development effort is certainly due in part to the fact that the project has addressed itself to needs actually perceived by engineering faculty: they want to know more about mini- and microcomputers. The success also appears to be due to the careful planning and conscious implementation of a series of strategies designed to involve faculty in the project. The attractive newsletters produced by the project were disseminated throughout the university, giving the project visibility and status. The information contained within these newsletters was selected to appeal to the needs perceived by non-project faculty. The leadership role in the faculty seminar series played by a respected senior faculty member (who previously held a high administrative position in the university) was also important. His personal and professional contacts throughout the university allowed him to effectively promote the project on an informal basis. His active participation in an area with which he himself had previously been unfamiliar (i.e., that of mini- and microcomputer technology) also increased the credibility of the project. Based on reports from participating faculty members, his aggressive and skillful leading of the seminar series played an important role in its success.

In general, the faculty development component of the Hilltop CAUSE project is impressive. It seems to have been well thought out, well implemented, and effective. The real proof of effectiveness, however, will be the extent to which faculty members who were previously uninterested in small computer applications use them in their research but, even more important, in their teaching. A thorough-going curriculum analysis, a clearer identification of areas of intersection with microprocessor principles, and the training of faculty in ways to integrate what they have learned into their curricula, are clearly the next priorities for faculty development.

Quality of instruction. The project focused primarily on faculty development, and for that reason its impact on instruction will be greatest during the final year of the project or during succeeding years. However, some effects on instruction already are in evidence.

The most immediate effect has been on the instruction given by the project director and other faculty members closely involved in the project. According to participants in the seminar series, other individual faculty have also been able to integrate newly acquired concepts related to mini- and microcomputers into the context of other engineering courses not directly related to computers.

The degree to which the project has additional, longer-term impact on instruction at Hilltop University depends on the ability of project staff to support individual faculty in their efforts to plan and experiment with additional course modifications. The difficulties that this entails can be seen in the efforts to encourage the instructional use of computer graphics through the offering of the computer graphics course and the provision of a resource person in computer graphics. While individual faculty have been made aware of certain limited capabilities of the computer graphics facility (e.g., the production of computer-generated illustrations of curves, waves, etc.), they have not been involved in the process of producing these materials themselves. More importantly, a system has not been put in place that will allow faculty to continue to take advantage of either the relatively simple graphics production capabilities or the higher level simulation and interactive capabilities of the computer graphics equipment. It appears that when the visiting professor/graphics expert goes, so will the opportunity to integrate computer graphics into ongoing instruction. This specific example illustrates the need for providing continuing support to many faculty members as they begin to experiment with new concepts in their instruction.

Evaluation. The evaluation techniques applied thus far are exemplary in their integration with the decision-making structure of the project. According to project participants, and as evidenced by the reports prepared by the Evaluation Board, the Board took its task seriously and aggressively examined the project at various stages in terms of the appropriateness of its goals (particularly with respect to the current needs of industry) and in terms of the validity of the approaches used by the project to achieve those goals. Evidence of the effectiveness of the Board includes specific changes made in the project in response to Board suggestions. The university administration expects the Board to continue its role well past the completion of the project.

Maples County Community College

General Background

Focus:	Adapting social science courses to the seminar approach
Budget:	From NSF: $176,790 From Institution: $ 89,028
Began:	June, 1978
Duration:	24 months
Date of Visit:	November 19-20, 1979
Visitors and Report Authors:	Jane G. Cashell and James J. Gallagher

Maples County Community College serves a geographical area of 839 square miles which has a large city at its center. Maples City has grown tremendously since World War II and is likely to continue to grow rapidly since it is located in the Sun Belt. The college began in 1966 with one city campus. In 1978 the seventh campus was completed and opened to students. Enrollment is approximately 37,000 students. Over 70 different programs are offered and include technical, occupational, academic transfer, and development studies. The college has an open door admissions policy, flexible enrollment, and provides special services to groups like the handicapped, veterans, and senior citizens.

The CAUSE project at Maples CCC was initiated by a sociology instructor at the downtown campus. In 1977 he applied for and received a Local Course Improvement (LCCI) grant from NSF to redesign his sociology course. He utilized a seminar and self-paced learning package approach to replace the traditional lecture approach. He took this approach because he believes there are several important reasons for doing so. First, many of his students are adults who have difficulty relating to the abstract nature of course material. The seminar gives them the opportunity to draw on their life experiences as examples of the phenomena being studied. Secondly, many students work full-time on rotating shifts. The self-paced learning packages can be completed any time during the week in the Learning Resource Center. Seminars are offered more than once a week so students can attend when they are available. Some students are not even able to enroll in a lecture course that meets three times a week during the same time block. Prior to LOCI most of his teaching experience was with lecture format courses. After he redesigned and offered his course he found his students responded very well to the new format. So he organized a group of faculty members from almost all the campuses of Maples CCC to apply for a CAUSE grant to redesign a number of courses.

The objectives for this project are numerous, but they explain in detail the intended activities of this CAUSE project. They are listed below.

1. To identify a minimum of fourteen faculty members in sociology, psychology, ecology, and/or earth science who are interested in and are willing to commit themselves to the program described below.

2. To provide these selected faculty with training for the production of materials necessary for a self-paced, experiential approach to education through the use of orientation seminars and explanatory materials.

3. To provide faculty with training in group process to facilitate and refine their involvement in and direction of seminars or small group sessions.

4. To create or adapt instructional materials including packages or modules to be used in conjunction with and as a supplement to the seminars or small group sessions in the various subject areas.

5. To reproduce instructional materials for student use in the spring semester, 1979; put them together in the form of a Teacher Resource Collection for distribution; secure any copyright permissions necessary.

6. To prepare, reproduce, and distribute assessment instruments and record keeping devices necessary for self-paced experiential education approach.

7. To prepare or adapt computer programs for keeping records of students' progress if such computer programs seem necessary to the individual faculty.

8. To write individual learning agreements between individual faculty members and students.

9. To prepare and reproduce Student Resource Manuals providing descriptions of learning materials and activities, papers, etc., references, bibliographies and information about preparation of learning agreements.

10. To set up administrative procedures necessary for the implementation of seminars and flexible-entry, self-paced approaches to the teaching of academic (science) courses.

11. To provide personnel for record keeping for self-paced and/or flexible-entry courses and for operating or aiding in the operation of an Individual Study Center.

12. To provide instruments for assessing cognitive styles, skills, and interests of students.

13. To implement two or more seminars or small group sessions, using the fourteen faculty members involved in this project, as a way of teaching courses ordinarily taught in a traditional classroom (large group) setting.

14. To supervise and evaluate the processes and structures described below.

15. To prepare a multi-media presentation demonstrating the results of this project.

Information on the Site Visit

During the two days we were able to visit three of the seven campuses of Maples Community College. The majority of time was spent at Campus One, a refurbished department store in the center of downtown Maples City.

The building has been redesigned and a new section has been added which provides additional office, classroom, and library space. Overall, Campus One is attractive and pleasant. It is well attended by students who either live or work near the center of the city. As is typical of central city community colleges, the student population is heterogeneous with a mixture of all ages, races, and ethnic groups.

Campus Two and Campus Three are located in the suburban reaches of the county. These colleges have new buildings and campuses set in beautiful countryside. Each is very different in architectural design and environmental setting and also very attractive. During the day, students in the suburban campuses are predominantly female and white but heterogeneous in age. Evening classes have a more balanced distribution of males and females.

During our visit we interviewed faculty, staff, students, and administrators, toured the campuses and learning resource centers, and observed some seminars. We had an opportunity during the visit and again afterward to review the syllabi and resource manuals created for the redesigned courses. The people we interviewed are:

-Project director and instructor of Sociology;
-Instructor of Developmental Psychology, Campus One;
-Instructor of Marriage and the Family course, Campus One;
-Student in Marriage and the Family, Campus One;
-Acting Chairman of the Social Science Division, Campus One;
-Vice-Chancellor of Academic Affairs, Maples CCC;
-Chairman of Social Science Division, Campus Two;
-Student in Marriage and Family who works in the Learning Resource Center, Campus Two;
-Instructor of Developmental Psychology, Campus Two;
-A group of Marriage and the Family students, Campus Two;

-Chairman of Social Science Division, Campus Three; and
-A group of students from Sociology, Developmental Psychology, and Psychology of Personality, Campus Three.

A tour and interview schedule was initially established by the project director. We asked him to make appointments for us to interview him "as well as faculty and staff in the CAUSE project, possibly some science faculty who are not part of CAUSE, some students, and college administrators". We did not specify who precisely we wanted to interview either by name or job title. When we arrived at Maples County Community College, the project director had arranged for us to interview most of the people listed above. We looked over the tentative schedule and discussed it with the project director. Additional interviews were arranged based on his recommendations and included the Division Chairman at Campus One and the Vice-Chancellor of Academic Affairs. We worked fairly closely with the project director during our visit.

Before starting our site visit, we reviewed the proposal, established a focus for the visit, and discussed our personal reactions to the proposal. The focus of our visit was two-fold. First, we wanted to get updated on the project. We needed to know what activities had been completed and what had not to date. Our second goal was to understand in detail, beyond that contained in the proposal, how the project functioned. We assumed that project activities had shifted and changed slightly in order to get the 'ideal' project of the proposal accomplished in the real world.

Our impressions of the project, at the beginning of the site visit, were that the proposal described an ambitious, organized, and carefully planned project. The needs given in the proposal as the rationale for the project seemed to be very important ones, well worth attending to.

Description of the Project

The CAUSE project at Maples CCC is aimed at improving learning by modifying some social science courses to better meet the needs of a diverse, non-traditional student population. The project emphasizes the development and implementation of new course syllabi, instructional materials, and teaching modes. Three-hour-per-week lecture courses were reorganized into one-hour seminar meetings once a week accompanied by self-paced learning packages. Seminars in most of the courses are held more than once a week so students can attend when they are available. The instructional materials in the learning packages include readings, quizzes, audiotapes, slide-tapes, and films and are available in the Learning Resource Centers at each campus.

Courses redesigned using CAUSE funds include Marriage and Family, Developmental Psychology, Psychology of Personality, Ecology, and Anthropology. The project began with the project director getting in touch with the Chairperson of the Social Science Division at each of the seven campuses and telling them about the project. They identified faculty members interested in instructional improvement. The project director made contact with these faculty members, told them about the CAUSE project, and asked them if they were interested in participating. Once faculty members agreed to work on the project, teams were formed for each course. They varied in size from two to four person teams.

The instructional development process began with the CAUSE project faculty being assigned release time for course redesign. They attended the project director's sociology course seminars and watched videotapes of his classes to learn about the seminar approach. Some of them were familiar already with self-paced courses which they or their colleagues were teaching. They all got together and heard from the project director what they needed to do to redesign their courses, what kind of materials they would be producing, and what type of format to use. Then they met in teams to redesign their courses. First content topics were debated and a course outline was developed. Each faculty member took responsibility for some of the topics. They wrote instructional objectives, researched the commercially available materials, created an exercise or quiz, and then organized learning packages. As a team they designed a variety of projects and paper topics from which students (and their instructors) could choose. A Student Resource Manual was created for each course which lists the learning packages and the topics for papers and projects.

The implementation of the redesigned course was accomplished by each member of the team at his/her own campus. The Student Resource Manaual and all the instructional materials listed in it were made available to each campus. Then the faculty member selected those learning packages and, if s/he wished, selected some topics for projects and created a syllabus for the course at that campus. The faculty member scheduled seminars to accompany the course, usually limited to fifteen students or fewer. Criterion levels for successful completion of each learning package and for the total course were set by each faculty member as well.

The project director designed a project management system to keep track of the course development teams' progress. He also provided them with assistance in the form of locating commercially-produced instructional materials and getting copyright clearance to use and duplicate the materials. He has monitored progress of the project through use of feedback forms completed by faculty members and the team. They are forms which provide process evaluations for: the print materials in each learning package; the non-print materials in each learning package; the paper or project topics; and and seminar topics for each week. The faculty member has to describe the pertinent content in detail and then describe or evaluate its use. The project director has kept track of all the courses and learning packages with a recording sheet for each faculty member.

The CAUSE project provided funds for release time, faculty travel between colleges, purchase of copyright releases, and commercial instructional materials acquisition. Preparation and production of the Student Resource Manual and the Teacher Resource Collection manual were covered by CAUSE as well. Because the redesigned courses made heavy use of the Learning Resource Centers at each college, some of the centers received funds to hire additional staff to help with the courses.

Use of the redesigned courses, after the CAUSE project is over, appears likely. However, the courses might not be used as widely or in exactly the manner in which they were designed. The courses are not popular with all students. A fine tuning of the course format and materials should be undertaken using the course evaluation data. Some changes in the courses may have to be done during regular teaching time because the release time and the project will be over. Also it is remotely possible that some of the campuses will not be able to cope with heavy student use of the Learning Resource Center which is part of the CAUSE courses. Currently some staff time for the Centers is provided by CAUSE. The Social Science Division Chairman and the Vice-Chancellor for

Academic Affairs seemed confident that support will be found to keep the resource centers going in full operation.

Issues

Institutional needs. The CAUSE project appears to be meeting an important institutional need which is to improve instruction to better serve a diverse, and non-traditional student body. Generally, if faculty want to improve their courses they must do so during the time available to prepare and teach the course. Since they have full teaching loads, the CAUSE-supported release time is giving them time to really work on their courses. In addition, because they are working in course teams across colleges, an opportunity which is not usually available exists for interaction, review, and critiquing among colleagues.

The faculty and administrators, whom we interviewed from all three campuses, appeared to be well prepared academically to teach their subjects. Moreover, they exuded enthusiasm and dedication for teaching and for the students who enroll in their courses. As is typical of community colleges, faculty members have heavy teaching loads and few are involved in publication, research, or other outside-funded projects. So CAUSE-funded release time for course redesign was critical to improving their courses.

The seminar and self-paced learning package design for courses was selected in order to increase student learning in two ways. First has been assumed that students will be more motivated to learn if they can relate personally to the content being presented. The seminar format is intended to provide a chance to share experiences and relate them to abstract concepts. Secondly, the master, self-paced approach provides different forms of instruction on each content topic. Students who cannot read well or who need reinforcement of materials are able to study at their own rate and pace using the learning packages. It seems that the CAUSE project was designed to meet real and important instructional needs at Maples CCC. It does not seem likely that release time and resources for instructional materials would have been made available from internal funds for the same purposes.

Project implementation. This project is a good example of careful project design and implementation. Fifteen objectives are detailed in three major categories: course development, staff development, and course implementation with students. Each is elaborated with specific activities and timelines for completion. At the time we visited the project, most activities were going according to schedule; some had been completed ahead of schedule.

Perhaps the most critical reasons for this are: the initiative, organization, and drive of the project director; dedication and quality of staff members from the various campuses that are working with him; and the cooperation he has received from division chairmen and other administrators. The project director has played a key role. He receives a high degree of respect from his peers.

The project director is unusual at Maples CCC because he is the recipient of an externally funded project. Seeking external funding generally is not encouraged (although not actively discouraged) by administrators. His project was developed because he and a group of faculty saw it as a means whereby they could obtain resources to augment activities they felt were of significance to the college and its students. Usually faculty work independently on instructional improvement as part of their regular teaching load rather than as part of a large scale project such as this one.

Among the greatest deterrents to the project's successful implementation are combined effects of the size of the area served by Maples CCC and the remoteness of the seven campuses from one another. This makes communication among the project staff difficult, especially on issues where decentralization is essential (i.e., testing and implementation of new courses). On the other hand, the CAUSE faculty appear competent and have the support of their chairpersons. This may help negate some of the communication problems. It is possible that the opportunity to interact with colleagues from the other colleges provides some of the motivation behind the successful implementation of this project.

An issue that could affect fully successful and complete implementation is the varied needs of students. Difficulties which blacks, Spanish-surnamed Americans, low achieving white suburbanites, and middle-class homemakers may have with learning abstract concepts may not be similar problems. Probably, within-group differences are also significant. For one it may be a matter of logic, for another language, for another a paucity of relevant experience, and perhaps, not all problems can be resolved by the same instructional approach. This issue has not been addressed by the CAUSE faculty members but it may be a critical one. If it does turn out to be a serious matter, it could have significant impact on implementation of the project in the several campuses which comprise Maples CCC.

Quality of instruction. The enthusiasm and dedication of the project director and the other faculty have resulted in the formulation of materials and the completion of faculty development activities that are carefully designed to improve instruction. Target dates have been met and the redesigned courses were being offered during our visit. Students meet faculty in a seminar format that allows for dialogue and personal interaction.

It is possible a potential problem has been created inadvertently by the project as a result of the best intentions. To meet student needs, the instructional mode adapted was the small group seminar format supplemented by self-paced instruction in the Learning Resource Centers. In order to have small seminars, it was necessary to reduce the amount of time that a faculty member spends in class with each student. Thus, each student has fewer hours of contact with a professor during a specific course than in a lecture format course. The trade-off between less contact and more personal attention had not been assessed at the time of our visit since most of the courses were being offered for the first time since being redesigned. A sizable percentage of the students we met and interviewed volunteered a preference for the more familiar lecture format. If this student attitude affects learning it will have to be examined closely by the CAUSE faculty.

Evaluation. As mentioned in the section above on project implementation, the project director created a comprehensive system for keeping track of the progress made on course redesign. Each instructor on each team was asked to fill out a form corresponding to each of the tasks of the course development process. The forms list the specific course development task under consideration, the information necessary to undertake the task, the decisions made to complete the task, and the instructor's comments and evaluation of the completed task. The project director set up an activity sheet for each instructor so he could monitor the overall progress of the course redesign process. This monitoring was especially important to the project given the physical distance of faculty members from the project director. Several of the forms created by the project director are shown in Figures 26-29.

The project director also had designed a comprehensive course evaluation plan which we had an opportunity to see during our site visit. A Likert-scale survey of student reactions to courses and student achievement on each learning package in a course is to be collected for each course. Faculty members will be given these data to use to fine tune their courses. Unfortunately since this is a two-year project, they will not have CAUSE-funded release time to do it. The project will end before then. The course evaluation had just started when we visited.

Summary

This CAUSE project offers an interesting example of a well-planned and organized project at a community college. That it was undertaken despite the remoteness of CAUSE project faculty members from one another is a credit to the motivation of the faculty, the project director, and the administrators who supported the initiation and continuation of the course redesign activities.

INSTRUCTOR

PROCESS EVALUATION

TITLE OF READING: ____________________

NSF/CAUSE CODE: __________

PROPOSAL OBJECTIVE #4: To create or adapt instructional materials including packages or modules to be used in conjunction with and as a supplement to the seminars or small group sessions in the various subject areas

CRITERION: A learning package on print materials including a list of objectives, a xerox copy of the reading or the original of the reading, an exercise or assessment component and an answer key.

GENERAL COMMENTS: ____________________

OBJECTIVES:

COVER PAGE- ____________________

SUMMARY/OVERVIEW- ____________________

EXERCISE: a)Instructions ____________________

b)Questions ____________________

c)Other ____________________

		GOOD	FAIR	QUESTIONABLE
CONTENT MATERIAL- (READING)	a)length			
	b)level of difficulty			
	c)appropriateness for course			
	d)interest value			

__________ Return PROCESS EVALUATION FORM with initials & comments

__________ Return copy of materials with appropriate changes

__________ Review material for errors (wording, spelling, etc). If errors, please note & return; if none, keep for your files.

__________ We need answer key for exercise

__________ Quality of copy ____________________

__________ You need to talk with ________ . ______.

RETURNED FOR REVISION __________

COMPLETED __________

CERTIFICATION __________
Project Coordinator

Figure 26. A form used by the project director to gather information from project faculty about instructional materials.

NAME: ____________________

NSF CODE	DESCRIPTION OF ACTIVITY	RECEIVED MATERIALS	FIRST DRAFT TYPED	EVALUATION FORM DONE	EVALUATION & MAT. SENT FOR REVISION	EVALUATION RETURNED TO US	REVISIONS TYPED	TYPED REVISIONS CHECKED BY DIRECTOR	REVISIONS NOT ADEQUATE-SENT BACK TO LCC	2ND REVISION RECEIVED & CHECKED	ADDITIONS YET TO BE MADE		MATERIAL COMPLETED	

Figure 27.
A form used by the project director to monitor the progress of courses being redesigned.

Instructor ____________________ Date of Evaluation ____________________

PROCESS EVALUATION

TOPIC OR TITLE: ____________________

NSF/CAUSE CODE: ____________________

PROPOSAL OBJECTIVE #45: To produce at least 15 lists of seminar/small group session topics with discussion questions or activities to be done

CRITERION: A set of seminar questions or a description of an activity(ies) to be done during 75-minute period. Emphasis will be on experiential activity rather than recall of subject matter of tests or packages.

EXPERIENTIAL NATURE OF QUESTIONS OR ACTIVITY

QUESTION OR ACTIVITY #	OK AS CONCEPT OR TEXT BACKGROUND QUESTION	EXCELLENT	GOOD	FAIR	QUESTIONABLE	TOO ORIENTED TO TEXTBOOK MEMORY OR KNOWLEDGE
#						
#						
#						
#						
#						
#						
#						
#						

Figure 28.
A form created by the project director to help individual faculty members and course development teams systematically gather information about in-class activities in a redesigned course.

______ This seminar question or activity would be better used as out-of-class or research activity or short paper or report.

______ Questions/Activity might not be sufficient for 75-minute period.

______ In view of above evaluation please add more experientially-oriented questions or activities and send back to Project Headquarters.

______ Return PROCESS EVALUATION FORM with initials & comments. ______
Initials

COMMENTS: ____________________

______ Review typed materials for errors (wording, spelling, etc.). If errors, please note & return; if none, keep for your files.

SUGGESTED CHANGES: ____________________

COMPLETED: ____________________ CERTIFICATION: ____________________
PROJECT COORDINATOR

RETURNED FOR REVISION: ____________________

INSTRUCTOR ______________________   ______________________
Date of Evaluation

PROCESS EVALUATION

ACTIVITY: ____

NSF/CAUSE CODE: ______________________

PROPOSAL OBJECTIVE # 4f: To create at least 20 short descriptions of papers and/or short research projects or independent study projects to be written or reported on by students. Emphasis should be on out of class activity.

CRITERION: One or more descriptions of a paragraph or more of an out-of-class activity to be completed by students. These can be job-related activities whenever possible, but should be experiential in nature in most cases.

EVALUATION COMMENTS:

____ Return Process Evaluation Form with intial and comments. __________
Initials

Any comments? ____

____

____ Review typed materials for errors (wording spelling, etc.). If errors, please note and return, if none, keep for your files.

SUGGESTED CHANGES: ____

____

____

COMPLETED ______________ CERTIFICATION ______________________
Project Coordinator

RETURNED FOR REVISION ______________

Figure 29. A form created by the project director to provide individual faculty members with specific directions for completing one course development activity.

Marigold College

General Background

Focus:	Improvement of astronomy courses and curriculum through the development of an observation facility
Budget:	From NSF: $30,900 From Institution: $15,455
Began:	September, 1977
Duration:	12 months
Date of Visit:	November 19-20, 1979
Visitors and Report Authors:	John D. Eggert and Robert E. Yager

A consortium consisting of twelve liberal arts colleges in the state (including Marigold College) submitted a proposal to NSF entitled "Improvement of Undergraduate Instruction in Astronomy by the Implementation of an Observation Center". In addition to the funds provided by NSF, an institutional commitment was made by Marigold College, the consortium member primarily responsible for planning the proposal and for providing the observation site.

Marigold College is a Catholic liberal arts college which enrolls approximately 1,500 full-time students each year. The college has limited enrollment in order to foster a personal atmosphere and a special community. It encourages its students to secure a broad and liberal education in the natural sciences, the social sciences, the humanities and modern languages and to gain professional preparation in nursing, education, or 3-2 engineering program in cooperation with a major university.

At the time the proposal was prepared four members of the consortium offered astronomy courses. The primary goal of the consortium is the strengthening of operations of member colleges through combined programs, particularly in the academic areas. Because of the cost of a program in astronomy, its limited availability in the twelve member institutions, and its existence as only an elective in natural science, the cooperative astronomy project was viewed as well-suited for CAUSE support via the consortium. The specific objectives of the project, as outlined in their proposal, included:

-provision for a permanent astronomical observation center for consortium institutions;

-improvement of astronomy courses by preparation of new curriculum units;

-provision for students to enroll in astronomy courses at all twelve consortium institutions;

-procurement of needed scientific equipment and A-V materials for astronomy courses; and

-encouragement of increased sharing of equipment, materials, and facilities among consortium members.

Approximately two-thirds of the combined $46,000 budget was dedicated to the construction of the observation facility and the acquisition of related supplies and materials.

Information on the Site Visit

During the pre-conference discussions we agreed that we would meet with staff, administrators, and students and tour the facilities as a team. The size of the staff and the institution as well as the small number of students involved seemed to preclude separate interviews and tours. Although the grant was aimed at affecting students and staff at twelve institutions, the project actually existed at only one college. Further, the project director was the primary person responsible for planning, establishing objectives, working on the project, teaching, ordering equipment, developing A-V materials, and supervising the building of the observation site, and so we spent a large amount of our time with him.

The initial focus of our visit was to determine the degree to which each of the proposed objectives had been met, and to understand the impact of a relatively small grant both on the college at which the project was located and on the consortium to which the grant was awarded. To these ends, we interviewed the following persons:

-The project director, instructor of chemistry and astronomy;

-The Dean of Marigold College;

-The Assistant to the President of Marigold College, responsible for writing the proposal and conducting negotiations with the staff of the consortium and of other consortium institutions;

-Three students (two science majors, one political science major) who made use of the facility in an astronomy course taught by the project director;

-The Chairman of the Physical Science Department at Marigold College;

-The Executive Director of the consortium; and

-The project evaluator, an instructor of philosophy at another consortium institution.

In addition, we inspected the observational facility; attended a class in astronomy in a classroom and at the observation facility; and reviewed course materials, the project evaluation report and other project documentation.

Description of the Project

The activities of the project can be grouped into three categories: those relating to the establishment of the observation facility, the acquisition of equipment and the development of supporting instructional materials; those relating to instructional activities at Marigold College which made use of the facility; and those relating to activities involving the cooperative use of the facility by consortium institutions.

The facility is located in the middle of an open field on land owned by the college, about a mile (by road) from the main campus buildings. The distance can also be walked in five or ten minutes by taking a shortcut through the woods bordering the field. The site was chosen for its proximity to the campus, access to electric service lines and distance from interfering artificial lights.

The small building is almost a cubicle in shape, its gray concrete block walls supporting a precast concrete roof. Extending from the double steel doors, padlocked for security, is a concrete patio large enough to accomodate a class-size group and surrounded by a chest-high gray block wall for wind protection. The building is simple and functional.

The interior is similarly functional in appearance. One wall has a small space heater. The room is lit by a red light bulb to preserve night vision. One side of the room is banked by cabinets containing photographic and other optical equipment. On a table is a radio used for time signals, and a variety of clocks. Along the opposite wall are the telescopes--a stout, six-inch in diameter Makutov type Vega telescope and a ten-inch Celestron telescope. Both telescopes are equipped with clock drives, allowing a given star to be tracked without readjustments.

Both are portable (the ten-inch is on wheels) allowing them to be easily set up on the patio and stored again at the end of a session. A variety of charts and reference manuals, many of which were purchased by the grant, are also stored in the building.

A set of 2x2 slide sets and accompanying audiotape presentations have been prepared as part of the CAUSE project. The slides provide various views of the stars and planets, and the tapes are of the project director's commentary and explanation of the slides. The project director was still in the process of completing the slide-tape services at the time of the visit, although he is already using part of it to augment his class lectures/discussions.

We had the opportunity to observe one of the project director's astronomy classes. Before class, the six students discussed their various projects with each other and with the project director. One had a series of photographs of the moon which he took through the ten-inch telescope; another had photographs of a difficult-to-observe constellation. While the students weren't generally aware of the source of the funding for the facility, they were clearly appreciative of increased accessibility to the equipment. None of the students apparently had any intention of making a career of astronomy, although one expects to teach astronomy as part of high school science. Their goals primarily seemed to be those of their professor's; that is, simply to become more aware of their celestial environment. Some of the students intended to pursue astronomy as a hobby.

At the time of our visit, very few cooperative activities related to the observation facility had occurred among consortium members. A dedication ceremony had been attended by representatives of member institutions, but the facility had never actually been used by member institutions. The evaluation conducted by a faculty member of another consortium college was the only other involvement in the project by consortium members.

Faculty from other institutions were reportedly unwilling to jointly develop materials; no exchange students from other member institutions have participated in the astronomy courses; and none have used the facility for instructional purposes. Based on conversations with the project director, the project evaluator and the consortium chief administrator, it appears that the other member institutions are not so much "uncooperative" as they are "disinterested". Most of them are located 20 to 80 miles from Marigold College, and this poses an inconvenience to both faculty and students (particularly since the astronomy course is an elective, not generally perceived as important in a specific sequence or preparatory program within the member institutions). Those two institutions that have their own equipment undoubtedly find it more convenient to undertake field observations closer to home. Finally, faculty at small colleges tend to be quite busy with their own teaching schedules and probably find working with other institutions an additional and unnecessary constraint.

Issues

Institutional needs. The astronomy program at Marigold College appears to have been in need of improvement. To the extent that the college served as a primary resource to the consortium in the area of astronomy (it was one of three of the member institutions with a formal astronomy curriculum), the consortium astronomy program can also be said to have been deficient. While Marigold College possessed the finest set of telescopic equipment in the consortium, there was no adequate facility in which the equipment could be used. Field observations had to be carried out by loading the telescopes into an automobile and setting them up in a vacant field. This naturally was too cumbersome to support a formal astronomy curriculum, and also posed a hazard to the equipment. Few would argue that astronomy courses that involve the observation of the heavens, incorporate student projects, and include the use of scientific instruments are not superior to textbook/discussion courses. Hence it seems fair to say that the project was important in terms of the science education needs of the students.

The project director had apparently made earlier efforts to procure funds internally for the purpose of constructing a facility to house the equipment, but was unsuccessful due to the fiscal constraints under which small colleges in general and the consortium institutions in particular are operating.

The other two consortium institutions offering astronomy courses have some telescopic equipment equal to Marigold's in quality although their facilities are not of as high quality. The proposal argued that the proposed facility would fill a need of the consortium institutions. It mentioned the intention to develop curriculum materials with the other member institutions and to generally share the new resource through the cooperative offering of courses and the creation of other joint ventures with other consortium faculty.

The need for the facility at Marigold College is apparent, but it is not clear that a need actually existed for the consortium as a whole. Although the project director and Marigold College administration took a number of steps to encourage such cooperation (e.g., representatives of all institutions were invited to attend dedication ceremonies presidents and academic deans of member institutions were formally notified of the opportunity and informal contacts were made by the project director), no member institutions have taken advantage of the opportunity.

Efforts are continuing to be made to involve other institutions with the new facility, but it does not appear likely that this will happen on more than a limited basis. We left with the impression that the need at Marigold is strong enough to justify the project, particularly since most of the equipment was already available, but that it appears to be a consortium need only in the sense that it is a need of a member institution.

Project implementation. The project objectives can be thought of in three categories: those related to the development of the facility; those related to the use of the facility by Marigold's faculty and students; and those related to the use of the facility by other consortium members.

The facility has been built, materials and equipment have been purchased as planned, and the observatory has been used by Marigold faculty and students on a regular basis. Although the project had somewhat of a late start because of last-minute changes in the exact location of the site, this aspect of the project has occurred successfully. The facility has been integrated into the astronomy course at Marigold, and some supporting materials are being developed by the project director (although they were not finished at the completion of the grant).

The third category of project objectives relating to cooperation among the member consortium institutions have not yet been successfully met. "Coordinated media units" to be developed by consortium faculty were not developed, no exchange students from other member institutions enrolled in the college's astronomy course, although the opportunity was made available, and very little, if any, sharing of the project resources has occurred.

In general, it can be concluded that the project was implemented successfully as planned, with the clear exception of virtually all those objectives related to the involvement of other consortium member institutions and the delay in the development of the slide-tape materials. It seems to be the case that the project staff was open to the involvement of the other institutions and communicated a willingness to cooperate through a number of official and unofficial channels. However, based on a lack of response to these initiatives, the interest and/or perceived usefulness of the facility by the other institutions was non-existent. The delay in the creation of the slide-tape materials, supported by less than 5% of the total budget, seems to have been a result of underestimating the time necessary to create such materials and to a lack of coordination between the project staff and the local A-V facilities.

Quality of instruction. As the previous discussion of specific objectives suggests, the project has produced significant improvements in the instructional resources available in astronomy at Marigold College. Construction of the Observation Center has been completed, necessary auxiliary equipment has been purchased and put in use, and the completed facility has undergone testing for two full semesters. Student evaluations of the facility indicate that it is operating effectively, requiring at most, minor modifications of scheduling and staffing. The only significant items yet to be completed in this area are the independent study carrels and some of the slide-tape sets.

Review of the objectives related to improvements in the astronomy curriculum also suggest substantial progress. As indicated by questionnaires, students have responded very favorably to the observation opportunities made possible through the grant, as well as to the use of films also supplied through grant monies. New student projects have been developed and new student interest has been generated in the study of astronomy. Fifteen of eighteen students responding indicated that they would take another astronomy course if it was available and, of these, fourteen indicated that they would prefer an "observational, photographic course" of the type which would utilize the new facilities.

Evaluation. The approach to evaluation in this project was to hire an outside observer from another member of the consortium. The evaluator designed a straightforward study around each of the objectives stated in the original proposal. Faculty and students were interviewed, student post-course questionnaires were administered, and field observations were made to determine the extent to which each of the objectives was achieved, the difficulties that were encountered (if any) in achieving them, and reasons for any objectives that were not achieved. Based on a reading of the evaluation report, and on an interview with the evaluator, it appears that the result of the study was an objective and comprehensive overview of the impact of the project.

The evaluator had virtually nothing to do with the proposal, the program development or the operation of the project. Yet he was nearby and able to interact with the director, the consortium members, college administration, the consortium officials and students. The evaluator took his task seriously and received the cooperation and support of the project staff. The report was explicit about those instances when specific objectives were not accomplished as originally proposed as well as those instances in which the objectives were accomplished. While the evaluation itself was not very complex, given the specificity and concrete nature of the project goals and the relatively narrow scope of the project, it was exemplary in its utility. It provided outside observers a clear understanding of what occurred and why, in terms of the objectives the project staff set out to achieve. In particular, the evaluation report served the useful purpose of cross-validating the information the site team acquired through its independent interviews.

Summary

The CAUSE project at Marigold College is an example of a small grant targeted at a specific need, i.e., the need for a relatively simple structure with a minimal amount of supporting materials and equipment to house already acquired telescopic equipment so it might be conveniently used. Although the facility was inexpensive to build, Marigold College is small and financial resources for that purpose have not been available.

The grant was actually proposed by a consortium of small colleges of which Marigold College was a member with the rationale that it would increase the availability of instructional resources to the consortium. While the facility is being regularly used by Marigold students and staff, to date the facility has been used only minimally by other consortium members. This appears to be due to a lack of interest and/or convenience on the part of other consortium members, rather than to any actions taken or not taken by Marigold project staff.

Rock College

General Background

Focus:	Preparation for the physical sciences (Remedial instruction in mathematics)
Budget:	From NSF: $13,050 From Institution: $ 7,215
Began:	June 1976
Duration:	36 months (plus 6 month extension)
Date of Visit:	December 6-7, 1979
Visitors and Report Authors:	Richard M. Lent and Robert E. Yager

Rock College is located on a hill overlooking a river valley. The campus includes a number of separate buildings: the main college building and three smaller college buildings/houses, a primary school, a now vacant high school, several dorms, and quarters for the religious order that runs the school. The college itself is housed primarily in one long, four-story building. This yellow brick building was built in the late 1950's when Rock College obtained its charter as a four-year college. Offices and classroom space in the building are heavily utilized and crowded, but clean and well kept.

Rock College has an enrollment of 830 full-time day students. The college also enrolls 150 part-time students, adults, and high school students. Sixty-five percent of the college's population commutes from the surrounding residential areas. The college offers degree programs in nursing (the single largest program), liberal arts, education (Rock College began as a normal school in 1930), and business (its newest program).

The CAUSE project was designed and directed by the Chairperson of the Division of Natural Sciences and Mathematics. The division includes three full-time chemistry faculty, a full-time physics faculty member, three full-time mathematics faculty, four full-time biology faculty and a number of part-time faculty. Most of the students affected by the CAUSE project were enrolled in science courses as a required part of the nursing curriculum. The project director explained that she had heard about CAUSE from a faculty member who had served on the NSF panel which originally formed the CAUSE program. While the college's Biology Department had originally intended to apply, when that department was unable to assemble a proposal the present project director (with some assistance from a physics faculty member) drew up her own.

A three-year CAUSE grant was awarded to the college in June, 1976 for a project entitled "Preparation for the Physical Sciences". The proposal grew from the faculty's recognition of the declining mathematical skills of incoming students. The problem was particularly acute in freshman chemistry and physics courses in which increasing amounts of time were being devoted to instruction in the necessary mathematical skills.

The decline in mathematical competencies was particularly notable in three types of entering students. First, there were those students identified as educationally disadvantaged and admitted to the college as part of the Higher Education Opportunity Program (HEOP). A second group of students consisted of older adult students who had been out of school for a number of years and had enrolled in the college's special weekend program for such students (The FRI-SAT program). The third type of student was the entering undergraduate who had gone through a "new math" curriculum in high school and, apparently as a result, was deficient in certain computational skills.

The CAUSE project was designed to support remedial instruction in mathematics and the language of science as needed by these various students in order to help them complete first-year courses in physics and chemistry successfully. Funding would be specifically used to further (1) the development of a testing system for identifying those freshmen needing remediation in math before undertaking chemistry and physics, (2) a five-week summer remediation program, (3) ongoing remediation sessions by faculty and upper class students during the regular school year, and (4) various evaluation and administration responsibilities. These efforts were to be conducted over three years. A total budget of $20,000 covered expenses for faculty time, instructional materials which included a set of self-instructional workbooks entitled Math Tutorials for Science and Technology marketed by Educulture, and equipment--hand calculators.

Information on the Site Visit

The project had just ended at the time of the site visit; thus it was possible to ask project faculty to review the total project and reflect on student outcomes, institutional improvement, and plans for continuing the instructional efforts. We were particularly interested in developing some appreciation for the magnitude of impact and general cost-effectiveness of one of the smallest budgeted CAUSE projects (only $13,050 from NSF over three years). Interviews were conducted to determine the nature of the project's remediation activities; faculty, tutor, and student impressions of those activities; project evaluation efforts, and any evidence of the project's continuing impact upon the institution. We also reviewed the materials used in all of the college's remediation activities -- summer courses, pre-lecture or laboratory sessions, and tutoring sessions. The people interviewed and their responsibilities are listed below in the approximate order in which we met them.

- -CAUSE project director and Professor of Chemistry and Chairperson of the Division of Natural Sciences and Mathematics.
- -Assistant Professor of Mathematics and instructor of summer remedial math course.
- -Director of FRI-SAT Program.
- -Instructor in chemistry and offerer of special remediation sessions during the semester.
- -Three upper class student tutors in chemistry.
- -Assistant Professor of Nursing.
- -Assistant Professor of Chemistry and instructor of summer remedial math course and special remediation sessions during the semester.
- -Instructor in physics for the FRI-SAT Program.
- -Lecturer in education and director of the HEOP program.
- -President of Rock College.
- -Instructor and tutor in physics.
- -Professor of Education and Academic Dean.
- -Assistant Professor of Physics and co-planner (with the Project Director) of the CAUSE proposal and the testing program.

- Director of the Skills Center.
- Eight students in the sciences who had participated in the summer remediation course, tutoring with upperclass students, or instructor-led special remediation sessions.

Description of the Project

At the time of the grant award in June, 1976, work was already underway on setting up the planned testing and remediation system. That spring 114 students planning to enter introductory chemistry or physics courses were tested using the Cooperative Mathematics Test, Algebra I (Educational Testing Service). Of this group, 33 students were identified as deficient and advised to better prepare themselves.

With the grant's arrival, some workbooks and the calculators were purchased. A pilot version of the summer remediation program was organized to run for three weeks in July 1976. Fifteen of the 33 students judged deficient in the spring testing were invited to participate. (Those 15 were the students who lived close enough to the college to commute since no college housing was available during the summer). Students from the college's HEOP program were invited to participate as well but none of these students chose to participate as HEOP already had its own remediation program in operation.

A chemistry faculty member conducted the three-week course for eight of 15 invited students. This course was subsequently judged as successful given that six of the eight students passed their science courses (the other two withdrew during the semester).

During the following years of the CAUSE grant, a variety of testing and remediation activities were conducted. The project director and other faculty redesigned the math proficiency examination to make it more suited to their purposes. A variety of approaches to the summer program were tried (e.g., offering it as a series of night classes) in the attempt to make it better suited to student constraints. A number of the project's original plans had to be modified due to the lack of summer housing for students; the fact that many students worked in the summer; the lack of participation by HEOP students; and most importantly, a change in the nursing curriculum which required students to take physics and chemistry in the freshman rather than sophomore year. Table 50 lists the various remediation activities conducted over the period of the project. (The dates of these efforts extend beyond the end of the three-year period because the final grant expiration date of November, 1979 allowed time to use some unexpended funds in the fall of 1979.)

In general, the levels of participation, and the effectiveness of the remediation efforts have improved over the three years. As the design of the summer remediation program was changed, enrollment went from 8 to 13 to 22 and, finally, to 35 students. Estimates in the project's third interim report suggest that the various remediation efforts enabled approximately 40% more students with identified math deficiencies to successfully complete their science courses than would otherwise have been the case. Given the resources she had to work with, the project director was satisfied with the project's achievements.

Other views of the project. As the site visit team met with various members of the college community, additional information was gathered on the project and on the role of the project director. We were particularly interested in learning more about the relationship of

Table 51

Summary of Math Remediation Activities Undertaken During the CAUSE Grant

Date	Description	Participants
July 1976	Three-week summer program conducted by a chemistry faculty member	8
Sept-Oct 1976	Series of remedial classes conducted by upper class chemistry major in conjunction with chemistry course	25
1976-1977 Academic Year	Four upper class tutors available throughout the year to provide individual help in chemistry and physics courses	Not recorded (Approx.30)
March 1977	Hour-long remediation sessions accompanied by special handouts developed by the project director given to those students identified as marginally deficient in certain areas	13
June-July 1977	Five-week summer program conducted by a chemistry faculty member	5
Summer 1977	Weekly remediation sessions provided to one student unable to attend daytime sessions	1
1977-1978 Academic Year	Five upper class tutors available throughout the year to provide indivicual help in chemistry and physics courses	Not recorded (Approx.30)
May, June, July 1978	Series of ten 2-hour evening sessions conducted to provide math remediation (a revised version of the original 3- or 5-week daytime summer program)	22
Summer 1978	Upper class tutor available to students retaking their chemistry course	14
Fall 1978	One-hour math and chemistry remediation sessions conducted by a chemistry instructor for those FRI-SAT students identified as needing help (through proficiency exam)	9

continued on next page

Table 51 (cont'd)

Date	Description	Participants
Fall 1978	One-hour math remediation sessions conducted by the project director and two chemistry faculty for freshman nursing students in chemistry identified as needing help (through proficiency exam)	30
1978-1979 Academic Year	Eight upper class tutors available throughout the year to provide individual help in chemistry and physics courses	Not recorded (Approx.60)
Summer 1979	Six three-hour evening sessions conducted by a member of the mathematics faculty (and two student assistants) to provide remedial math instruction to FRI-SAT students and others	35
Fall 1979	Upper class tutors available to students needing help in chemistry and physics	Not recorded (Approx.40)

CAUSE-supported remediation activities to the College's various programs and the remediation activities offered by HEOP and the Title III-supported Skills Center.

One of our interviews on the first day was with a member of the mathematics faculty and instructor of the most recent summer remedial math program. This faculty member described the project director as a leader and innovator at Rock College who had spent many of her summers working on the CAUSE project in spite of the fact that she was not getting paid and technically had no college responsibilities during the summer. We also asked this mathematics professor what she thought about the participation (or lack thereof) of the HEOP students in the CAUSE-supported remediation efforts. She said that she felt that the HEOP program seemed to provide adequate support to its students as HEOP had the funds to support faculty and student tutors to work with their students on a one-to-one basis. While she thought that this approach might isolate those students, it also helped them deal with their special problems.

Later in the visit, the site team had an opportunity to talk with the director of the HEOP program. She explained that she had never seen the CAUSE proposal and had been relatively unaware of its contents in spite of the fact that the HEOP program had been specifically mentioned as a source of students who needed the services to be provided by the project. The director explained that the HEOP students had a unique set of problems and needs which meant that they required a different kind of attention than did the rest of the college's students.

Specifically, she felt that only a few of the upper class tutors in chemistry and physics had ever been able to work effectively with the HEOP students.[1] The tutors did not realize the extent to which the HEOP students needed to be reached out to and, instead, waited for students to request help from them. She explained that small group remediation sessions were also not effective as, "Our kids aren't aggressive enough to get enough out of small-group situations."

At another point in the visit, we met with a group of three upper class students who were serving as chemistry tutors. We also had a chance to observe some of their tutoring activities. All three seemed to know the topics they were tutoring quite well and to have a certain amount of instructional presence. Some of their comments suggested that they attached a certain importance and status to being tutors. All of them seemed to work hard at being good tutors, maintained regular hours for tutoring and were concerned about their ability to meet the needs of their students. Generally, they professed a certain amount of personal allegiance to the CAUSE project director and most of them had worked for her as tutors for several years. They clearly saw themselves as tutors for chemistry and physics courses and did not relate their efforts specifically to the math remediation programs.

We also met with several of the science faculty who had been involved in one aspect of the project or another. Generally, these faculty were not well informed about all the various remediation activities that had been conducted; they were mainly familiar with those aspects of the project in which they had participated. The CAUSE project was not seen as a specific kind of effort involving a particular group of faculty. There had been no formal communication about the project within the department. Individual meetings with each faculty member had been called by the project director to work out various activities. All the faculty supported the remediation activities as having had a beneficial impact upon the quality of their course offerings.

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[1] The project director later commented that the tutors had always worked with any HEOP students that showed up for tutoring sessions. Furthermore, the project as a whole had consistently followed the HEOP office's "oft-stated desire ... to have the HEOP students treated just like any other students'."

CAUSE project impact on instructional quality was also the subject of a conversation with the college's full-time physics faculty member (and co-planner of the CAUSE project). The physics professor said that she and the CAUSE project director had initiated the testing program to assess the mathematic skills of entering students. This testing had been tried for a year before the CAUSE grant. They used a standardized test, but decided that the standardized test was not responsive to their needs and designed their own. She felt that the testing program had really helped the students as it warned them what they would need to pick up in order to succeed in the courses. She felt that, as a result, they had been able to upgrade science courses rather than keeping them low enough to meet the entering level of the students. When asked if her students were performing more successfully in physics as a result of the tutoring, she said that there would be no way to determine this since she used norm grading and, thus, always had the same distribution of students across grades.

Overall, there was generally strong support for the claim that the CAUSE project has had a number of important impacts upon the college.

In our conversations with the director of the FRI-SAT program, the CAUSE project director pointed out that the special remediation sessions developed for these part-time, adult students would never have come about without the impetus of the CAUSE project. Later, a chemistry faculty member pointed out that the college, initially, had not been inclined to put money behind remediation efforts (such as hiring tutors), but now that CAUSE had supported these activities, the college seemed more willing to continue them in the future.

A specific example of the CAUSE project's unintended impacts on the college and the college's support for continuted remediation efforts was evidenced by the development of the Study Skills Center. When the college had been developing its Title III application, the CAUSE project gave them the idea to request money to support tutoring - specifically through the creation of a tutoring center. At the time of the site team's visit, the responsibility for funding the tutoring effort had been recently transferred from CAUSE to the new Skills Center which would maintain and expand upon the original tutoring concept.

During our closing interview with the project director, the CAUSE project was described as having supported a period of experimentation with remediation techniques at the college. A wide variety of techniques for identifying students needing help and then providing that help had been tried. Now, however, the college was entering a period in which the most cost-effective and efficient remediation approaches would have to be identified in order to be maintained. A number of signs of attempts to institutionalize key elements of the remediation efforts were noted; however, the future continuation of a summer remediation program seemed doubtful.

In closing, we asked the project director what would have happened had she asked for more money. Specifically, she was asked whether the college would have "swallowed" a $100,000 to $200,000 grant. She said that at that time it would have been "too overwhelming and required too big a commitment on the college's part." The project director then observed, "I think the CAUSE grant was the first faculty-developed grant in my 13 to 14 years at the College. Since then, other faculty have come to me to ask about grants and the number of faculty writing grants has grown." As we left, the project director gave us a copy of her new CAUSE proposal explaining that, while she realized we did not have anything to do with the CAUSE program per se, if we happened to have a chance to put in a good word for the college. . .

Issues

Institutional needs. Conversations with faculty, administration, tutors, and students in addition to the evidence of mathematics proficiency tests attest to the need for this remediation effort. It seems clear, also, that the college could not have supported these remediation efforts (particularly the summer program) without external funding.

Project implementation. The objectives of the project remained constant throughout the life of the project. They were to (1) identify incoming physics and chemistry students with mathematics deficiencies by means of a testing program; (2) offer a summer remediation course for those needing it; (3) provide on-going remediation by faculty and upper class tutors while instruction in chemistry and physics was offered; and (4) evaluate the success of the remediation efforts.

In general, the project was able to address its objectives in a satisfactory manner although not everything went as planned. Particular difficulties were encountered with the summer remediation course (the second objective). Those difficulties included the initial timing of the CAUSE award (relative to plans for conducting a remediation program in the first summer); the lack of participation by HEOP students; the reorganization of the nursing curriculum; and the inevitable conflict between the work responsibilities of FRI-SAT students and the requirements of a week-day program. As a result, the summer program was able to serve fewer students than expected - only a fraction of the total group who could have benefited from such services. A number of efforts were made to modify the design of the summer program to make it more workable and those efforts have met with some success.

Efforts to address the project's first and third objectives proceeded more smoothly. The tests used for identifying the need for remediation have reportedly worked well. Special instructional materials developed or purchased by the project director seem to have been effective and well-received by students. The two forms of delivering remedial instruction during the semester (instructor-led special class sessions and peer tutoring) appear to have functioned effectively and seem likely to continue in the future.

The major difficulties in implementing these activities have had to do with the limited time available for faculty to participate in and administer the project due to heavy teaching loads. There also appears to have been a less than optimum amount of communication and coordination among the various remediation efforts now present at the college: HEOP, CAUSE-supported, and the new Skills Center. (It should be noted, however, that the project director has made a concerted effort to address the needs of the HEOP students as consistent with the focus of the CAUSE project.)

In spite of its small size, the project has had a number of secondary and/or unintended impacts upon the college. According to the faculty, the development of remediation efforts has led to curriculum changes and an overall improvement in the quality of the college's offerings in chemistry and physics. From the comments of several faculty it is also apparent that the CAUSE grant has served as a sort of general catalyst for other efforts to obtain outside funding such as the Title III grant. Finally, the college administration and faculty are reportedly more aware of the academic preparation differences of incoming students and the various means of overcoming those differences.

Quality of instruction. There is considerable evidence to support the belief that instruction in the sciences has improved as a result of mathematics remediation efforts. Faculty report that their courses are of higher quality than they otherwise could have been. More students are succeeding in the introductory physics course (although the same percentage fail as before, since a normative grading procedure is used). Innovative instructional techniques (use of hand calculators, individualized modules, and upper class tutors) have been introduced and accepted. In short, the project appears to have achieved a range of improvements consistent with its level of funding.

It appears that several aspects of the project will be continued in the future. The Skills Center has assumed responsibility for the salaries of upper class tutors The college administration has also agreed to continue support for faculty-led remediation efforts accompanying regular science courses. The likelihood of continuation of the summertime remediation program, however, is uncertain. This program is the most difficult remediation effort to maintain and a new CAUSE proposal has been prepared by the project director to support its continuation. Discussions are underway regarding the feasibility of charging students for the remedial instruction and the science and math faculty are planning to standardize the mathematics proficiency test as part of the college's admissions procedure.

Communications with the project director six months after this site visit was completed showed these estimates of the nature of continued CAUSE-initiated instructional improvements to be accurate. The tutoring and testing programs were continuing. Self-study workbooks were still being prescribed for those students identified as needing help. The summer remedial program, however, was not conducted this year. The college's new proposal to CAUSE was given a generally favorable review but not funded. Several proposal reviewers identified a particular weakness of the new project as the extent of its support by the college administration.

Summary

All in all the remedial efforts at Rock College have benefited the college, the faculty, the upper class students serving as tutors, the special FRI-SAT student group, the half of the incoming nursing students who are deficient in basic mathematics, and other general students needing mathematical remediation for science. There is considerable evidence that faculty and student morale is improved because of the remediation efforts and the CAUSE grant. There is also evidence that the CAUSE grant has affected the college administration, the nursing program, the conceptualization of the emerging Skills Center, and the cohesiveness of the Division of Natural Sciences at Rock College. The small grant has resulted in many improvements in the instructional program which may be lasting ones. One can only wonder what would have happened had the grant been larger.

Sage City College

General Background

Focus:	Instructional uses of the computer in the physical sciences and engineering
Budget:	From NSF: $101,400 From Institution: 87,727
Began:	June, 1977
Duration:	24 months plus 6 month extension
Date of Visit:	November 15-16, 1979
Visitors and Report Authors:	Richard M. Lent and Thomas Allen, Jr.

The college's pleasant campus sits on a hill overlooking the city. Sage City is the county seat of Smith County which has a population of 200,000. It is located in one of the southwest's major food production regions about 100 miles from a large population center. The region's economy is based on agriculture and petroleum.

Sage City College was established in 1913 and currently enrolls about 14,000 students (8500 FTE) in a wide variety of college transfer, career, and general education programs. It is a community college run by the county and it takes pride in the fact that, for many years, it was the local higher education institution. (This situation changed in 1970 when the state college system opened a branch at Sage City.)

The college has a wide variety of offerings in the sciences. Twenty-five faculty handle an enrollment of 4000 students a year in the life and physical sciences. The CAUSE project is located within the Physical Science department which accounts for over half of all science enrollments.

A series of events in 1975-1976 set the stage for the present project.

Up until this time, Sage City College had no real instructional computer capability. The college's one computer was primarily devoted to administrative record-keeping. In 1976, Sage City College, under the auspices of the local community college district, purchased a Digital Equipment Corp. PDP 11/70 and set up its first computing center devoted strictly to instructional use. That fall a group of faculty from the Life and Physical Science Departments submitted a proposal to CAUSE for a project to support faculty use of the computer in their courses. When this proposal was turned down, a committee of faculty from the Physical Science Department as well as the Coordinator of the new Instructional Computing Center (ICC) redesigned the project changing its orientation from training to development. The primary author of the new proposal was Dr. Nelson, a chemistry professor, but all project participants contributed with ideas, reviews of written material, and some sharing of the writing task. Dr. Russell was named project director since he was departmental chairperson and better known to NSF. This proposal was ultimately funded (as was another proposal submitted to ISEP by the ICC Coordinator to fund additional terminals for the computer).

The final proposal described the demand for this project in terms of the general necessity of incorporating computer use within an undergraduate science curriculum. This project was designed specifically to facilitate the incorporation of the computer within certain physical science and engineering courses by exposing faculty to available materials, and by giving them the necessary release time and additional terminals with which they could both program and adapt materials for use in their courses. The proposal described project activities as occurring in three phases:

> Phase I involves the determination of the most effective means by which computer use can be integrated into specific courses in chemistry, engineering, geology, and physics. . . During Phase II, faculty participants will both adapt and develop computer materials for the specific needs of the courses in their respective discipline areas. . . . Phase III will consist of a summative evaluation which will include further analysis of data and reports resulting from the summative evaluation. (Project Summary)

Information on the Site Visit

As we prepared for our site visit to Sage City, we were aware that we would be arriving during the last weeks of the project's existence. From reading the proposal it was evident that the project involved a mixture of faculty development and materials development activities along with some equipment purchases.

The proposal generally seemed to provide a clear outline of the project's intended activities. This was particularly true in the evaluation area where, compared to other CAUSE proposals, the proposal described an explicit role for formative and summative evaluation activities. The one area that was not clear from the proposal was the project's expected outcomes in the areas of faculty and materials development. In planning the visit it thus was decided to conduct a kind of open-ended or goal-free investigation of the project's impact on the college. Particular attention would also be given to the project's own evaluation activities since it was assumed that this project might be better than others in this respect.

When we arrived on campus, we proceeded as planned to Dr. Nelson's office. Dr. Nelson, new Chair of the Physical Sciences, was working at a CRT terminal by his desk. We introduced ourselves and were soon involved in a detailed discussion of the project's history, philosophy and activities. Dr. Russell, the project director, arrived about fifteen minutes later (but Dr. Nelson continued to be the major source of information on the project). It was in the course of these discussions that the site visitors first realized that Nelson, not Russell, was the primary force behind the project.

A series of casually arranged interviews with other project members followed. Project Director Russell was usually present during these interviews. A formal meeting was scheduled with the college president. Some serendipitous opportunities for interviews with two non-CAUSE faculty in Psychology and Chemistry also arose. Overall, we interviewed the following people:

- Dr. Richard Nelson, Chairperson of the Physical Science Department, Professor of Chemistry, and Advisor for Educational Strategies and Evaluation to the CAUSE project;
- Dr. John Russell, Professor of Engineering and Geology, CAUSE Project Director, and past Chairperson of the Physical Science Department;
- Professor Charles Deland, Coordinator of Instructional Computing Center, member of the CAUSE project;
- A Professor of Chemistry and member of the CAUSE project;
- A Professor of Physics and Astronomy and member of the CAUSE project;
- The President of the College;
- The Dean of Instruction;
- A Professor of Psychology involved in instructional computing, but not a member of the CAUSE project; and
- An Associate Professor of Chemistry and Industrial Drawing who was not a member of the CAUSE project.

Two efforts to publicize the CAUSE project within the college were noted during the visit. A display case outside the Science and Engineering Building contained pictures of the Instructional Computing Center and a description of related activities. We were also given a copy of the college's research and development newsletter (Spring 1979) which contained an article by Dr. Nelson reviewing the CAUSE project's accomplishments.

In the course of the two days, several attempts were made to observe and interview students working at terminals at two campus locations (the Science and Engineering Building and the Instructional Computing Center). Terminals appeared to be in almost constant use. During the site visit, however, no students were seen working on science materials developed under the project. Instead, most of the students were working on a data processing course. Use of the various instructional materials developed under this project was demonstrated by several project faculty, and the ICC Coordinator.

Description of the Project

The CAUSE proposal was submitted in November of 1976. This was the first year of operation of the college's new instructional computing facility. During that year (prior to the arrival of the CAUSE grant) a few faculty began working with the computer, but Dr. Nelson was the only member of the science faculty to become actively involved in its use. The ICC's Coordinator had a part-time (60%) responsibility for the Center's operation.

With the arrival of the CAUSE project, a number of things changed. First, the Computing Center's facilities were augumented by several new pieces of equipment including four new CRT terminals (placed in or near the CAUSE project faculty members' offices). Second, Deland's responsibilities as Computing Center Coordinator were increased to those of a full-time position. And third, the Physical Science faculty's use of computer services increased as Nelson and the other project members began their developmental activities.

Project activities. In spite of the fact that a substantial portion of the project's budget was devoted to equipment purchases and computer center costs, the project's major emphasis (as described by both the proposal and participating faculty) involved the development of faculty computing skills and the integration of the computer as an instructional tool in physical science courses. The project got off to a good start with equipment purchases completed and a variety of faculty development activities underway by the end of the first six months. As reported by Dr. Nelson in his role as Project Formative Evaluator, the project's activities up until January 16, 1978, included:

1. CAUSE group meetings were held on September 8, November 10, and January 13. These meetings included discussions of project objectives, reports of conferences, and the general operation of the project.
2. The State Educational Computing Consortium meeting was attended by Nelson and Deland.
3. The Northern State Community College Computing Consortium meeting in Concord was attended by Nelson, Deland, and another faculty member.
4. Meetings were held with consultants.
5. Informal reports of project activities were made to the Computer Use Committee.
6. All proposed project equipment was received and is in place and operating.
7. A workshop on computer tools and techniques was given for project participants and other faculty by Deland and Nelson on January 13.
8. One student was hired on a part-time basis to assist participants.
9. A Student Consultant Committee was formed in the Chemistry area to review programs and give suggestions. So far, the committee has reviewed a number of Nelson's programs.

10. A student consultant questionnaire was prepared by Nelson and was used with the committee mentioned above.

Not everything went as smoothly as it may appear here, however. Project Director Russell noted that they had some trouble actually obtaining the necessary hardware in time to meet the project's schedule. They also had considerable difficulty finding good replacement faculty to handle the CAUSE project faculty's teaching responsibilities.

Similar project activities continued over the next year. These included CAUSE group meetings, attendance at various computer consortium meetings and visits with consultants. But the most important aspect of the project was occurring at the level of individual faculty working on integrating the computer into their courses.

The four faculty members on the project were all provided with release time for project activities over the two-year period; however, most of them did not divide up their time that evenly. Nelson used all of his first year's release time at the project's beginning by taking the whole first semester off to work on the project. Project Director Russell and the professor of chemistry each used all of their first year's release time at once by devoting the whole second semester of the first year to the project. The professor of physics and astronomy was the only faculty member who divided his release time across several semesters. Some implications of these different divisions of release time were noted by several faculty. The chemistry professor commented, in retrospect, that he felt he had taken too much of his release time too early in the project. Meanwhile, the physics/astronomy professor felt that the fact that he never was able to devote a whole semester to the CAUSE project alone meant that other responsibilities had always stolen time from his project activities. Whether or not any of the project faculty had release time during a particular semester, they generally kept active in the project. Nelson and the physics/astronomy faculty member, in particular, seem to have incorporated computer activities as an integral part of their regular responsibilities.

How a faculty member used his release time varied from person to person. Project Director Russell took a computer science course and devoted his efforts to identifying potential instructional uses and available software for his surveying, geology, and engineering courses. He had found some use for the computer in his surveying course in assisting students with some of the more complicated mathematical computations. In his other instructional areas, however, Russell stated that he had not been able to find a great deal of relevant computer applications and that, "What materials exist are usually in upper division topics."

The chemistry professor worked on developing original materials to accompany one set of his chemistry courses. He had found three uses for the computer: to provide a means of drill and practice in certain topics, to maintain student records, and to provide a kind of bulletin board service for the students. Both the chemistry professor and Project Director Russell viewed the computer more as a means of instructional enrichment for their courses than as a means of replacing or revising current instructional activities. The chemistry professor taught himself to program the computer (using a textbook) and found it to be a rather frustrating experience. He would have liked to have had someone who could have worked with him on computer programming for several weeks.

Nelson and the physics/astronomy professor were the faculty who got most deeply involved in a range of instructional applications of the computer. Both had some previous experience working with computers and both were enthusiastic about the instructional potential of the computer.

Nelson described a variety of applications of the computer he had developed for use in his courses. First, he established a computer-generated, interactive, testing system. This was combined with a student course record system which keeps track of the points and general performance of each student on the test. Second, he used the computer to provide drill and practice activities for the students. Here, the main intent was to get students to spend additional time going over various concepts learned in class. These materials were intended to accompany rather than replace regular lecture and lab activities. A third area of computer use was with experimental "check" programs. These programs asked the students for their data from lab experiments and reviewed those data for their reasonableness. It then could give either some limited corrective feedback or actually provide the right answer. Nelson felt that the use of various computer programs helped to save class time in terms of managing quizzes, improving the accuracy of student experimental reports, and helping to simplify some of the math problems that confronted students (but which were not necessarily part of the chemistry learning objectives). Finally, work on additional computer applications involving simulations and computerized "experiments" was noted as well.

The professor of physics and astronomy, along with Nelson, had learned to program the graphics terminal. While he had developed some effective but fairly simple instructional programs for astronomy, he had also begun designing more sophisticated programs (such as an interactive program on electric fields and equipotential plotting). He saw instructional uses of the computer as a means of improving student motivation arguing that: "If you can motivate students sufficiently, they generally have enough natural ability to learn the material."

Up to the time of the site visit, all project evaluation activities had been handled by Nelson as the formative evaluator. He explained that: "In terms of formative evaluation, I saw my role as simply keeping my eye on things, informing people of progress." When the site visitors asked about summative evaluation activities Nelson commented that, "We were really unclear about that--I assume [the external consultant] is supposed to look at what we said we'd do versus what we actually did."

Outcomes. Since the project was in its last weeks at the time of the site visit, it was possible to ask project participants for their own assessment of the outcomes.

Computer Center Coordinator Deland explained that the combined impact of the CAUSE and ISEP grants had really expanded the college's computer capabilities. They had tripled the college's original stock of ten terminals, added graphic terminals and a telephone (dial-up) capability. Before CAUSE, Nelson had been the only member of the science faculty using the Computer Center and now seven faculty in the physical sciences alone were actively working on computer programs. If he had the project to do over again, however, Deland said that he would have stretched the project out over a four-year period with the first year devoted just to teaching faculty to use the equipment. Some difficulties in getting the faculty to commit themselves to learn the necessary programming skills was noted.

The college's president stressed the point that, in his opinion, the main benefit of the CAUSE project was its impact on the area of faculty development. "CAUSE permitted us to free up the faculty. The equipment purchases were minor by comparison." He explained that he felt that CAUSE had resulted in a regeneration of the areas of science and business and that faculty had spent much more time working on the project than had been budgeted or intended. The president noted that the project had come at just the right time in the college's history. However, one major unanticipated result of CAUSE had been that the college had already had to add additional memory to its computer at a cost of $13,000.

Finally, Nelson commented on his view of the project. "As I started this project, I tried to think of everything I wanted to do and made a list. I went back to that list the other day and I found I could put a check beside almost every item." When we asked Nelson whether the project's objectives had changed over time, he said that they had. Specifically, most of the objectives dealing with student outcomes of the project had been dropped from immediate consideration as not directly relevant to the main focus of this project. The faculty development aspect of the project had assumed increased importance.

Nelson explained that he felt one of the major results of this project was that it demonstrated to the faculty what the computer could do. Most of the faculty had not been familiar with instructional uses of the computer prior to the project. It was noted, however, that little had been done to disseminate the results of the CAUSE project to other science faculty beyond the five faculty who were members of the project team.

Finally, in response to a question asked about whether the project's proposed budget had proven to be accurate and appropriate to project demands, Nelson noted areas of both surplus and shortfall. As for surplus, Nelson explained that the project had allocated an unnecessary amount of money for equipment maintenance contracts. Recently, the money had been transferred to the permanent equipment account--enabling the college to purchase more terminals. By contrast, the project had been underbudgeted in the area of faculty salaries. The project's budget had been based on the estimated cost of replacement faculty and those replacement faculty had been difficult to find and more expensive than anticipated. Nelson estimated the extra expense borne by the college in this area to have amounted to $5,000 or more.

Issues

Institutional needs. The need for Sage City College's CAUSE project was justified in the proposal by general reference to the place of computers in any post-secondary science education program. This general need was further defined in terms of the specific goals of the college's science education program (as established/verified by a survey of the college community). The relationship between the college's goals and this project was summarized as follows:

> The [Sage City] College goals of providing quality science education, critical thinking skills (actually a part of any good science course), and effective articulation with four-year institutions will be directly promoted by the use of computer systems in Physical Science courses. A fourth goal, that of developing student skills in earning a living, is promoted indirectly by making students' education more complete and up-to-date. . . for those students who may find their knowledge of computer operations a saleable skill in the marketplace. (Local Review Statement)

The general premise that computers have a fundamental role to play in post-secondary science education is easily accepted and provides a basic justification for this kind of project. Sage City College had already demonstrated its commitment to this idea by establishing an instructional computing center. With the general need and its local importance established in this manner, the issue of project relevance to local needs can be more specifically considered in terms of whether the project's objectives were justified as a means of achieving the desired status of computer applications within Sage City College's science program.

Two sets of objectives were established for the project. The first dealt with the development of faculty capabilities in and development and utilization of instructional applications of the computer. A second set of objectives described intended student outcomes resulting from increased computer usage. These student objectives, however, really represented a secondary outcome of the project itself and, as the developmental phase took longer than expected, they could not be given active consideration within the project. The major focus of project activities as well as the main justification for most of the project's hardware and personnel expenditures had to do with the faculty development aspect of the project.

Given the newness of the college's instructional computing facility (six months old at the time of the proposal), it is quite reasonable to expect that faculty would need some assistance and support if they were to put the new computer capability to effective use within their courses. In the proposal, three possible alternatives to the CAUSE project were discussed. These included leaving the development of computer applications to individual faculty as time and interest allowed, providing faculty release time from the college's general budget, and using outside consultants. Problems with the feasibility and effectiveness of each of these alternatives were noted in support of the project's chosen approach. These problems seem real and the CAUSE project appears to have been both a realistic and justifiable approach to the situation. If CAUSE had not funded this project, it seems unlikely that the college would have supported the effort on its own and the integration of the computer into Sage City's science offerings would have proceeded at a much slower pace.

It therefore seems that this project was designed to address a high priority institutional need. Some question could be raised, however, as to whether the scope of project activities and impact matches the size of the identified need. Since the project's faculty development efforts only involved a few of the science faculty with no means of disseminating project impact beyond those few faculty, one wonders how the rest of the faculty are expected to develop their own computer skills and develop applications for their courses. There is evidence, however, of increasing interest in instructional applications of the computer among the college's faculty.

Project implementation. It would have to be concluded that this project was conducted as planned. However, the plans for this project were general enough that this kind of congruence could be expected. Aside from equipment purchases, project activities mainly involved providing faculty with the time to learn about and develop computer applications as appropriate to their courses. Individual faculty had relatively complete control over the nature of their activities and outcomes.

There could be some question as to whether faculty were given the best mix of project resources to accomplish their tasks. First, questions as to the timing of project efforts were raised. One faculty member took a little time off each semester which he found to be dysfunctional since in any one semester project responsibilities were competing with too many other responsibilities. Other faculty took all of their first year's time off in one semester, which was inappropriate for some of them because it did not allow for the kind of lead time and down time that the project's materials acquisition and development efforts required. (Nelson noted, however, that he could tackle major projects with minimal distractions.) Second, the lack of direct support to the individual faculty's programming efforts may have had an adverse impact on project outcomes. Specifically, the nature of available programming support reportedly limited some faculty to more simplistic computer applications than might otherwise have been the case. At least one faculty member specifically expressed a wish that a programmer had been available to work with him for several weeks. (This is in spite of the fact that the ICC's coordinator and programmer were available to provide assistance. Some attempt to make use of student programming assistance was tried but not found to be too successful.)

Overall project leadership and management was provided by Dr. Nelson. While Nelson was not the official project director, he was the primary author of the proposal and the project's local authority on the use of the computer as an instructional strategy. In his role as project formative evaluator, Nelson prepared the interim progress reports and used these reports as a management and communication tool within the project. These formative evaluation reports documented specific accomplishments; noted particluar problems encountered; and suggested ideas, strategies and priorities for upcoming activities.

Dr. Nelson also appears to have fulfilled the role of change agent, although "change" was not that big an issue in the project. Since individual faculty had a fair amount of autonomy over their project activities, each could determine the extent to which he would become involved in computer applications. In general, faculty have created computer applications that represent additions to, rather than revisions or replacements of current instructional practice.

Quality of instruction. As discussed earlier in this report, the project had several direct and indirect impacts on the capabilities of the computer center, increased the number of science faculty employing computers within their courses, and increased the number and variety of student encounters with computers. Two of the project's faculty members developed a range of computer applications for their courses--applications that could have a demonstrable impact on the instructional effectiveness of those courses. The other two faculty involved with the project have been able to develop more limited applications for their courses--applications which will at least familiarize students with computer use even if they have little to do with instructional effectiveness per se.

Utilization of materials and equipment acquired through the project generally seems to be proceeding as expected. There have been some temporary setbacks due to changing teaching assignments which result in a faculty member developing materials for one course and then teaching another. Fortunately, this is not a frequent or permanent situation and the project members seem to adopt each other's materials easily.

The impact of this project should continue in several ways. First, project members are likely to maintain at least some applications of the computer in their courses. The two faculty most involved in innovative programming efforts will probably continue to expand the possible applications of the computer within their courses. The impact of CAUSE-financed equipment purchase will also continue. CAUSE money may have arrived at a key point in the evolution of the Instructional Computing Center. CAUSE's presence may have helped the Center to acquire the critical mass of both physical and personnel resources to have a real impact on the instructional life of the campus. Specifically, some mention was made of the indirect impact of CAUSE funds on the development of a computer science program for the college: while not related to the CAUSE project, the boost given to the Computing Center reportedly advanced the start of this program by several years.

Additional long term effects of this project are possible due to the increased interest in obtaining outside funding that was generated by this project. Dr. Nelson was active in a new proposal to CAUSE to fund additional faculty development activities in the area of instructional computing.

Evaluation. The project made good use of formative evaluation activities, but plans for summative evaluation had not been carried out at the time of the site visit. (A fairly perfunctory report was later received from the project's external summative evaluator.) As described earlier under the discussion of implementation issues, Dr. Nelson's conduct of formative evaluation efficiently accomplished the project's internal management and communication tasks and the external reporting requirements to NSF.

Summary

Sage City College's CAUSE project was a modestly sized project which effectively achieved its primary goals. The project operated efficiently and resulted in a number of improvements in the physical science faculty's instructional activities through a variety of computer applications. The college now has a well-established Instructional Computing Center. The only question that could be raised about this project is whether the addition of a third year and a few more dollars would have significantly advanced the overall impact and cost-effectiveness of this effort.

Sands College

General Background

Focus: The creation of a laboratory center to support the expansion of a science curriculum

Budget: From NSF: $100,000
From Institution: 60,500

Began: June 21, 1977

Duration: 24 months

Date of Visit: January 10-11, 1980

Visitors and Report Authors: John D. Eggert and Robert E. Yager

Sands College, founded in 1966, is a four-year liberal arts and business administration institution. The average age of its 2200 full and part-time students, 90% of whom live within 30 miles of the college, is approximately 30. Sixty percent of the courses for a given term are taught by a full-time staff of 30 persons, the remainder by part-time persons. Over a quarter of the 78 faculty members have doctorates. The tuition at Sands College, a private school, is low ($33/semester hour of credit); the tuition is quite competitive with state schools and is two to three times less than other private schools in the area.

The campus is located within the city of Sands where the first building was converted from its original industrial use when classes began in 1966. Other buildings were added including a student union, a library-gymnasium complex and, very recently, a science center (the major focus for the CAUSE grant). A new health science complex and a new humanities center are all in advance planning stages.

Sands grants Bachelor of Arts and Bachelor of Fine Arts degrees with eleven majors in business administration and the liberal arts. The

Division of Science and Mathematics offers majors in mathematics and in physical education. As more interest develops and the need is established, one or more additional science majors might be developed. However, science, as it currently exists, primarily serves as a part of the general education core curriculum and provides needed supplementary courses for other majors.

Sand's CAUSE proposal was written as a means of realizing part of a five year development plan that included renovating a commercial building (an old lumber yard office) into a science center. The property (land totaling 1.5 acres) was adjacent to the campus and included a 4,000 square-foot building and a large building that had been used for lumber storage.

The major objectives of the "Sands College Science Development Project" included:

-renovation of a commercial building into a science center consisting of two laboratories (one for chemistry and biology and one for physics and experimental psychology), three faculty offices, an animal room, and associated preparation and storage areas;

-procurement of new equipment for chemistry and physics instruction (neither course had been part of the science offerings prior to this time);

-development of new science courses (choosing texts, developing syllabi, employing needed instructors) for Sands students; and

-evaluation of the renovation, procurement of equipment, and the course development efforts by students, faculty administration and outside consultants.

Information on the Site Visit

With a relatively small college and number of staff included, we decided to conduct the visit as a team effort. We contacted and interviewed all involved administrators, faculty members, and support staff as well as representative students and members of the community. Specifically, we interviewed the following individuals:

- -The Project Director, Chairman of the Mathematics Department;
- -The Academic Dean of the College;
- -Three full time faculty who used the laboratory facilities to teach biology, chemistry and psychology;
- -A part-time faculty member who used the facility to teach physics; and
- -Approximately 24 students who used the new laboratory facilities.

We also reviewed the new equipment, the renovated facilities, and curriculum/course materials developed. The primary focus of the visit was to assess the need, implementation and outcomes related to the principal objective of the project, as stated in its proposal ". . . to create a laboratory center to make fundamental improvements in its delivery of undergraduate science education."

Description of the Project

The primary emphasis of the CAUSE project at Sands was on the development and equipping of a new laboratory facility where none previously existed. The development of new science courses, accomplished by the faculty chosen to use the new facilities, consisted primarily of selecting texts and outlining syllabi. Project evaluation played a relatively minor role in the project, involving the use of an external review team and the collection of student feedback.

The new laboratory facilities have been developed almost from scratch, as virtually no laboratory facilities were previously available. The 19x19-foot room that had been used as the biology "laboratory" in the main building had no facilities for gas, water, or sewage systems. There was also a severe shortage of space and cabinets to house the limited equipment they did own, and there was a need for a variety of basic laboratory equipment. The previous office space was too small to hold student conferences, the care and feeding of live animals was problematical and, we were told, it was generally difficult to teach a lab science in the then available facilities. In fact, chemistry lab courses had to be taught at the local high school. One faculty member succinctly summarized faculty perceptions of science in the pre-CAUSE era at Sands: "It was terrible."

The present facilities are an improvement. The old lumber yard building (it apparently had been the front-office, retail area of the business) is now divided into two large, modern, well-equipped laboratories. Each lab is approximately 30 feet wide by 40 feet long, and each has space for approximately 32 students. Lining the walls are ceiling-high, glassed-in storage cabinets filled with the previous equipment (much of which had been unused for lack of easy access) and there is approximately $20,000 worth of new basic lab equipment supplied by the CAUSE funds. In addition to the two laboratories, three offices of adequate size (with soundproof windows overlooking the labs) were built, as was a small animal room. The facilities are presently in full use, supporting courses in chemistry, physics, experimental psychology and biology. The courses are based primarily on the texts selected for use in the course by the relevant department chairman or other full time faculty. Course syllabi are developed informally by individual faculty. Formal curriculum development efforts are difficult to support given a heavy teaching load and a relatively large proportion of part-time faculty. No funds to support any personnel were included in the project budget.

Issues

Institutional needs. The need for chemistry and physics offerings in a four year liberal arts college is obvious. In addition, the need for laboratory settings for instruction in biology, experimental psychology, chemistry, and physics was established prior to the preparation of the CAUSE proposal, by North Central Association (NCA) evaluators and by the visitation team members when the room previously used for biology and psychology was visited.

The need for the science center, the equipment and supplies, chemistry/physics offerings was identified as the top priority of the college in its five-year plan. The need was recognized by the administration, the board of directors, the faculty and the students. The 1.5 acre site had been secured by the college; the commercial building on it had been studied for conversion into a science center.

The new science center has become the newest building on a growing campus. It has been fully integrated into the campus plan, the college catalogue, and the day-to-day operation of Sands College. A critical institutional need has been met with the help of the CAUSE grant. The project has been completely "institutionalized."

Project implementation. The objectives which were stated in the proposal were all met in the time frame specified. The attractive science center with its two laboratories, office space, animal room, and support/storage areas is in full use. The added courses in chemistry and physics are a part of the natural science offerings at Sands and the staff additions that were necessary have been made.

Successful implementation of the Sands College Science Development Project can be seen by the physical features of the new center, an enthusiastic staff, motivated and excited students, demands for more science offerings, and near capacity use of its facilities and equipment. Change has occurred; chemistry and physics are being offered; enrollment, especially in chemistry, are greater than anticipated; the laboratories, equipment, and program are all operating well. The CAUSE grant enabled Sands College to accomplish a major renovation of a commercial building into a science center, procure needed equipment and supplies, significantly expand the science curriculum, and add to the science staff. The CAUSE grant was not as much a catalyst for change as a means for the needed change to occur.

Quality of instruction. The impact of the Science Development Project upon Sands College has been great. It has become a source of pride for the entire faculty, for the student body, and, apparently, much of the community. Sands College has had unusual community support from its inception in 1966. The new science center is a facility of the college which is recognized and supported widely.

The offering of chemistry and physics for the first time on the Sands campus is certainly an improvement. Particularly, the student demand for even more courses in chemistry and biology (they have tripled in a year) is evidence that students want more science and are most satisfied with the quality of the courses they are experiencing. Faculty opinion, student feedback, and reports from outside consultants all attest to the improvement in science education at Sands College which has resulted from the CAUSE grant.

The feelings among students concerning the new science center are extremely positive. The grant and the new center have stimulated thinking about an eventual science major at Sands and the need for other courses in science for the unique population of students served.

Significant improvements have been realized for the experimental psychology program. The equipment, the animal room, and the laboratory are all exemplary. This program appears to be functioning well and represents a great improvement over the situation prior to the CAUSE grant and the opening of the science center.

The science program at Sands will almost surely continue to expand. There are obvious student needs; there is administrative and faculty support. The new center was well planned and is functioning well as the place "where science is" at Sands College. There is very little chance that the activities of this CAUSE project will be discontinued.

While the science courses as conceived and the instructional procedures followed are not particularly innovative, the introduction of standard laboratory courses has itself been a great improvement as the limited science program prior to 1977 did not involve laboratory instruction in any real sense.

Evaluation. Informal evaluation is extremely important in a college such as Sands. Meeting the real needs of students is a major concern. The college is small and the student population comes almost totally from the immediate community.

Students are asked to complete an evaluation form concerning the teaching and the content of each course they complete. Similarly, faculty members are asked to complete an "End of Course Evaluation" form. Division chairs are also expected to collect evaluation information and to make regular recommendations regarding academic promotion and salaries of the faculty working in their respective divisions.

All of this "regular" evaluation information has been used for the science offerings. The information dealt with effectiveness of the laboratories, the course material, the scientific apparatus, the instructors, the teaching strategies. As might be expected from the preceding discussion, these evaluations were all very positive providing evidence that the objectives of the CAUSE grant had been met.

In addition to the standard faculty and student evaluation procedures, four consultants from neighboring universities were to have visited classes and the campus on four occasions prior to preparing formal reports. These reports as well as faculty and student evaluation materials were to have served as raw material for a two-day evaluation conference planned for June 1979. The conference was to have included the four faculty members listed in the proposal, the two new faculty members, the four outside evaluators, and the academic dean. This two-day conference was to have outlined needed changes in courses, in instructional materials, and in the curriculum generally. Because of time and logistical constraints, the evaluation conference was never held. Also, the evaluation reports by the outside consultants seemed to be more peripheral to the project than suggested in the proposal. Two of the reports seemed merely to verify that the objectives of the proposal had been met. It is unfortunate that the evaluation plan in the proposal was not implemented more fully. It could have been a significant experience for the staff and provide practice with strategies for stimulating change and improvement.

Summary

The CAUSE project at Sands College is an example of a carefully planned and implemented project. Major objectives were met that fulfilled real needs. New equipment/supplies, new science courses and the renovation of a building into a science center were all accomplished. The institutionalization of these changes argues well for an improved capacity for undergraduate science education at Sands.

Sea University

General Background

Focus:	The development and implementing of a Center for Instructional Computing
Budget:	From NSF: $249,500 From Institution: $172,000
Began:	September 1, 1977
Duration:	36 months
Date of Visit:	November 15-16, 1979
Visitors and Report Authors:	John Penick and John D. Eggert

Sea University is a private liberal arts institution with an enrollment of approximately 2600. It is unusually well endowed and is currently exercising a policy of controlled growth including a building and resource acquisition program, particularly in science-related areas. An 8.5 million dollar chemistry building was completed in 1974, a biology, sociology and physics building has been recently renovated, and the central computing facilities have been upgraded. Especially important to the present CAUSE project is the College of Letters and Science's new Learning Center, a three-story building costing over 2.6 million dollars. The Learning Center contains classrooms and seminar rooms designed for audiovisual presentations. Special attention has been given to computer use including the installation of computer tie-lines, space for time-sharing computers, and provision for classroom projection of computer output. The Center for Instructional Computing (CIC) developed through this CAUSE project is located in this new building and represents Sea's first major step toward utilizing its instructional computing capabilities.

Some instructors had developed instructional computing programs prior to the establishment of a CIC but, according to the proposal, these efforts were limited for the following reasons: 1) the lack of personnel support for faculty unfamiliar with instructional uses of computers; 2) the difficulty faculty experienced in taking time away from their research to develop computer-based instruction; 3) the lack of a centralized library of already available computer-based programs, and 4) the lack of physical support facilities, particularly student terminals and classroom display equipment.

The CAUSE project is designed to address these problems through the establishment of a Center for Instructional Computing to provide physical facilities and personnel support for faculty wishing to develop and use computer-based instructional materials. Specifically, the objectives of the CIC are the following:

1. To provide service, support and encouragement to science instructors and students developing and using computer-based teaching materials;
2. To evaluate the effect of these new methods on the science curriculum; and
3. To provide physical facilities needed for the new teaching and learning activities.

Information on the Site Visit

The site visit activities consisted primarily of a series of interviews conducted with the project staff, participating faculty and university administrators. We also reviewed documents relating to the project, observed students using the computer-based programs developed through the project, and actually worked through eight to ten of the instructional modules.

We arrived at the project interested in learning more about a number of specific areas. We were interested in understanding the roles of the various individuals involved in what appeared to be a faculty development as much as a facilities development project. We wanted to know how faculty were motivated to participate, the extent to which they were able to participate and the extent to which materials were actually developed and used in the classroom. We also wanted to determine the extent to which the project was integrated with the rest of the institution, or if it was likely to be only a temporary development project with no lasting effects. With these and other questions in mind, we interviewed the following persons:

-The Project co-director, Associate Professor of Sociology;
-The Project co-director, Associate Professor of Physics;
-The project evaluator;
-The full-time project programmer;
-Six part-time student programmers;
-The project secretary/text editor;
-A faculty developer, Chairman of the Psychology Department;

-A faculty developer, Professor of Chemistry;

-A faculty developer, Professor of Economic Anthropology;

-A faculty developer, Professor of Biological Anthropology;

-The Dean of the College of Arts and Sciences; and

-The project steering committee (in a group discussion format).

Description of the Project

The Center for Instructional Computing (CIC) at Sea University is directed by a Professor of Sociology and a Professor of Physics, each of whom has had substantial experience in instructional computing in the context of his own courses. The basic aim of the center is to encourage students and faculty to use computer-based teaching materials. These materials are developed by paid programming staff using ideas from individual faculty members. In addition, the staff of the CIC hopes to evaluate the effect of computer-assisted instruction on the science curriculum and to provide the physical facilities needed for these new teaching and learning activities. One of the center's main learning goals is to institute computer-assisted instruction which is more imaginative than mere drill and dialogue, for example, computer simulations.

The facilities of the CIC consist of a collection of time sharing computer terminals clustered in one room of the new Learning Center building with other terminals scattered throughout the campus. The staff consists of two half-time directors, one full-time programmer, a half-time secretary, and about ten student programmers.

The heart of the computer-based instructional support system is the program caller, a computer program through which individual instructional programs may be accessed. Some 122 separate programs from 11 science disciplines are available. Most of these programs have been developed at the university under the CAUSE grant. All new students are given a one-hour orientation session on how to access these materials and are encouraged to use them freely.

Student programmers act as CIC representatives in the main terminal cluster at all hours of operation. They help students with procedural problems associated with accessing the programs and work with students in academic areas in which they are knowledgeable. The student programmers also work with individual faculty members in the actual writing of computer programs. They are assisted in this by the full-time programmer who was also responsible for writing the program caller. In addition, the full-time programmer writes some programs for faculty and provides a great deal of guidance in instructional design and heuristics for individual programs. The half-time secretary types the narrative of all the programs, provides proofreading services, and reviews instructions for clarity in addition to doing all other normal secretarial tasks. The two-half-time directors function largely as advertising agents for the CIC. They visit regularly with faculty in the sciences to generate more interest in writing programs and to provide technical and moral support to faculty who are currently developing programs.

The procedure used to develop instructional materials is as follows: a faculty member proposes an idea to the CIC steering committee which is made up of all department chairmen in the natural and social sciences; then, the steering committee approves proposals and authorizes release time to the individual submitting the proposal. The proposer is also given access to a student programmer in the CIC. Then the student programmer, the faculty member, and one of the CIC staff have a brainstorming session to determine how the faculty member's idea can be put into practice. The student programmer, following the instructions of the faculty member, then creates a workable program. The full-time programmer provides technical aid to the student programmer while the project co-directors reassure faculty that what they are doing is appropriate. Once the program is on line, the project evaluator provides data on how many people are using programs. Information on all programs on line is made available to all students, and all students can access any program at any time.

Virtually all students now have an I.D. card to use the terminals and all freshmen, sophomores, and juniors have gone through a one-hour orientation session on how to log in and out. Every university student is provided with 1,000 CPU seconds per month and can purchase additional time for $15. Any programs they use as part of a course are charged to that course and their 1,000 seconds is strictly for their own experimentation.

Some departments have begun adding terminals of their own and others are considering terminals. Sea University has a decided advantage in having almost every building on campus hard-wired to the computer center.

One of the more innovative uses of equipment has been the use of Advent video projectors to project the terminal images on a large screen in the auditorium. Two Advent projectors were bought by the dean out of separate monies and the Math Department has also bought Advent projectors with their own money.

The computer-based instructional modules developed by faculty through the use of CIC resources vary considerably in terms of instructional sophistication and breadth of content. One relatively straightforward but very popular set of exercises was developed by the Chemistry Department. Chemistry is the largest undergraduate program on campus with nearly four hundred students, most of them pre-meds. These students are very grade conscious and are very interested in reviewing materials to help them do better in chemistry. To facilitate this, one chemistry professor put all of his old tests on the computer so that students could work through the materials and then get an indication of how well they did. He feels that this is far more effective on the computer than it would be on paper because the students cannot just mechanically memorize the answers; they must look at each problem and think about whether the answer is correct or not. This program, GENCHEM, is the most used program in the CIC. The professor likes it well enough that he has had his lecture room hard-wired for a terminal so that he can use the GENCHEM materials in his classroom during review sessions.

The chairman of the Psychology Department has developed a diagnostic program which he uses an an enrichment in his child psychology course. He feels that he was a most unlikely candidate for anything dealing with computers because of his ignorance and that he agreed to get involved primarily to provide an example for his faculty. He is now sold on computers and is even beginning to use the computer in his research. His diagnostic program, for example, presents a child with several symptoms. The child is underweight and is a poor eater. The student is asked to provide questions that could be asked of the child or the child's parents. The student is then given a score based on correctness and appropriateness of the questions asked and on the accuracy of the diagnosis.

A biological anthropologist originally became involved with the CIC in implementing a program developed by another university. He then moved on to develop his own projects because he felt that he could do a better job himself. He has developed a review program called "Bones" which is first used by students as a test and then as a study aid in basic anatomy. After a series of lectures and readings on human evolution students may go to the CIC and call up a program which, in essence, describes an anthropological site and all of its artifacts. Students attempt to name the various artifacts and early men who may have been associated with the site. The program requires that all names be spelled correctly for the computer to accept the response. The professor feels that as a result of these programs students feel better about their learning and the course and that he has been saved from a large number of trivial student questions. He believes that the CIC has made it easy for faculty by providing programming help. He thinks the help has been exceptionally good in that once he gives the center staff an idea on paper they can turn it into an almost finished product. In the future he would like to develop programs on half-life to determine dates of objects, and he would like to design a graphics program which would demonstrate some locomotive patterns of various animals.

The center facilities are presently being used on a regular basis. The terminal room, open an average of 62 hours per week (35 hours per week during the summer), is staffed by student programming assistants during all open hours. Data collected by the project evaluator indicates that there has been an average of seven students logged-in at the terminal room during sampled half-hour intervals. (Intervals sampled were all half-hour intervals during the fifth and tenth weeks of each quarter). 719 of a total of 966 freshmen invited to attend one-hour CIC orientation sessions actually attended these sessions. Programs were accessed at the rate of approximately 1500 times per month during the second half of the project's first year. This use rate jumped to over 2500 times per month during the second year of the project. At the time of the site visit 122 individual programs were available for student use. A total of 22 faculty proposals had been awarded support by the end of the second project year, 14 of which were actually implemented. (Those not implemented were dropped for various reasons including that relevant staff left and underestimates by faculty of resources required to implement the proposal were made. Proposals have been received from faculty of all but one of the university's 10 science departments. While university administration could not specify the level of university commitment to continuing the CIC, the high usage of the center and the administration's commitment of resources to it seem to suggest that it is likely to continue after the termination of the grant.

Issues

Institutional need. The needs addressed by this project can be seen at a number of levels of generality. The need to improve the effectiveness of undergraduate instruction is a continuing need at any university. Likewise, the need to increase the level of computer literacy among students and faculty is a fairly common one due to the rapid changes in computer technology and application in recent years. The CAUSE project at Sea University addresses these common needs by capitalizing on a number of unique circumstances at the university. The recently upgraded computer facilities and the availability of the new Letters and Sciences Learning Center building were resources waiting to be used. The activities of the project directors in computer-based instruction served as a field test of a variety of logistical aspects of the project and provided a useful foundation for further development. In addition, according to a number of faculty, Sea University places a greater stress on quality of instruction than most other research-oriented institutions and thus provides fertile ground for project activities.

Although the facilities and institutional climate prior to the CAUSE project were conducive to meeting the need to improve instruction and expand computer literacy, they were not sufficient. What was lacking was a mechanism that would provide individual faculty with the motivation and technical support necessary to take advantage of the university's resources. The project provided support to establish the critical mass of facilities and professional and technical support necessary to establish an operational system that would allow faculty to become involved in module development when they would not otherwise have the motivation and/or know-how to proceed on their own. The availability of personnel and facilities also made it a relatively easy matter to introduce in a hands-on mode approximately 75% of all new students to the university's instructional computer facilities. The open access to computer-based instructional modules and computerized games, combined with the possession of free computer time to each student, undoubtedly leads to a greater familiarity with the use of computers by Sea students.

Project implementation. This project is being implemented aggressively by recuiting faculty, helping them develop ideas, and insuring that those ideas are put into effect. Successful implementation in this program seems to depend on several factors:

1. the highly motivated co-directors;
2. the ease with which faculty members can become involved and get materials produced for the computer;
3. the clientele guaranteed by involving all new freshmen;
4. the high level of support provided by central administration.

A commendable characteristic of this project is the efficiency with which individual project personnel have been used. Faculty members were able to develop computer-based instructional programs with a minimum amount of effort because their time and talents were used only where they were needed most--in the development of the substantive aspects of the modules. The project directors were used to help faculty members to brainstorm ideas, to provide political and professional clout to the project, and to act as liaisons between the project and other areas of the university. The full-time programmer was able to create the computer programs much more efficiently than either the faculty or the project directors because of his experience in this area. Likewise, his technical abilities allowed him to supervise the student part-time programmers which also freed up the project directors for the more general administrative and planning tasks. (However, the project directors did continue to develop their own programs).

Individual faculty were provided release time by the university to participate in course development efforts. However, a number of faculty indicated that this approach was not workable. In some cases, faculty members felt that they could not afford to put a lot of effort into instructional efforts, even when release time was provided, since their research was so important to them personally and professionally that it monopolized the largest part of their time and energy. Other faculty, particularly those in small departments reported that even though individual faculty were released from specific responsibilities (e.g., the teaching of a course) no additional resources were added to the department to take care of those responsibilities. Thus, the "released" faculty member would either have to continue to take care of his or her original responsibilities in addition to the instructional development tasks, or the obligations would have to be shifted to another faculty member within the department who already had a full complement of responsibilities. One of the project directors felt that rather than providing release time to project participants, individuals should be given a fixed fee, in addition to their normal salaries, for the successful completion of an instructional development project. This, it was felt, would provide additional motivation to participate in such efforts and would show recognition of the fact that participating faculty actually perform such activities in addition to their normal responsibilities whether they have been formally provided with release time or not. While the project directors believe that they have been successful in persuading individual faculty members to develop instruction, they also feel that more would be done if faculty could be so motivated.

Another possible weakness in the project is its lack of personnel with experience in innovative instructional design. As a result, many of the programs on the CIC system seem to be less powerful and less interesting instructionally than they could possibly be.

Certainly, it appears that the right project directors were chosen (both seem well respected and strong in their respective areas); careful planning has been done and is continuing to be done; the administration seems quite efficient both in communications and implementation; and the project is working well with strong institutional support.

Quality of instruction. This project is having a great impact both on faculty and students. The impact on faculty has come about because of the assertive nature of the directors and the high competence of the paid programmer. The directors have done quite well at convincing faculty members to provide ideas which the paid programmer could then implement. Once these programs are a reality and on the system, it is an easy enough matter for the faculty member to recommend to classes that they use them. Student use, reports of which are sent to the individual faculty member, provides reinforcement for the faculty member to continue using that program and to help develop others. It seems an almost painless effort for the individual faculty member involved. The impact on students is guaranteed by having every freshman student go through a one-hour orientation on how to access the program caller. This, in essence, guarantees high student use, use which is enhanced by the variety of games also available on the terminals. What is being developed is a first step in computer literacy for the students--getting their hands on the equipment and doing something which they understand.

There is no direct evidence that the quality of instruction is being improved, but certainly the variety has been. Another indication of some evidence for instructional improvement is heightened faculty interest. It would seem that if faculty are more excited about what they are doing, they probably are communicating this to students, and improving their instruction. The CIC also provides a topic of conversation for faculty and students. Such activity can't help but improve communication about instruction.

Evaluation. Although a proposed objective of the project was "to evaluate the effect of [the new instructional approaches] on the science curriculum", little formal evaluation has been done on this project. The collection of statistics on student usage provided useful data, but much more could have been done. Project staff reported some resistance to a formal evaluation of their efforts, and the evaluator mentioned that faculty did not actively seek out assistance in project evaluation. However, it could be argued that just as it is important to make it easy for faculty to become involved in instructional development activities, it is equally important to smooth the way for their involvement in evaluation activities. Undoubtedly some evaluation activities occurred in the context of the project; e.g., during the deliberations of the steering committee and in the informal discussions between project staff and faculty. However, without the benefit of a more focused evaluation of the instructional quality of the new methods it will be possible only to claim that instruction is different at Sea University, but not necessarily better.

Summary

The CAUSE project at Sea University is an example of the effective use of existing resources for the improvement of instruction through a well-planned and coordinated faculty development effort. The most important characteristic of the project is the degree to which personnel resources are efficiently utilized so that instruction can be created with the least possible effort on the part of individual faculty. The project has been fairly successful in achieving its goal of increasing the instructional use of computers at Sea University, but has not yet acheived its objective of evaluating the quality of this instruction.

Springs University

General Background

Focus:	The development and evaluation of alternative curriculum utilizing individualized and computer-based instruction, an intern program and a science center
Budget:	From NSF: $289,100 From Institution: $295,545
Began:	July, 1976
Duration:	36 months
Date of Visit:	November 8-9, 1979
Visitors and Report Authors:	John D. Eggert and James J. Gallagher

Springs University, founded as a normal school in the latter part of the nineteenth century, has since progressed to a teachers' college, a state college, and, finally, a state university with an enrollment of approximately 11,000. It is one of several state universities and includes five undergraduate liberal arts and professional colleges and a graduate school. Like many other universities in the United States, it experienced a fairly rapid expansion of enrollment during the 1960's and a relatively rapid decline during the early 1970's. The resulting fiscal retrenchment, which included the strategy of dropping tenured staff from the faculty, led to extremely low faculty morale but also created the impetus for the development and implementation of an extensive and comprehensive annual planning process characterized by "(i) a high degree of faculty, staff and student participation, (ii) integration of goals and objectives and priority setting at all levels, and (iii) base-reallocation of the budget to effect desired changes and program improvements."

The planning model, the development and implementation of which was partially funded by external sources, occupied a great deal of faculty and administration time in its early stages and resulted in the development of explicit departmental, college and university goals and objectives. These plans were evaluated at the departmental and college levels by faculty committees (in terms of each plan's relationship to university goals as well as to the overall program quality) the conclusions of which were used to direct a policy of reallocating university resources to the best programs and faculty.

One of the strategies used to operationalize this resource reallocation was to modularize the university calendar. In addition to allowing more students increased flexibility in their programming, this allowed faculty the opportunity to reschedule portions of their normal academic load to summer sessions. Three- or four-week sessions during the normal academic year were thus freed up to allow staff to participate in specific faculty development activities funded by the university in response to proposals competitively submitted by individual faculty members. (This university program also provided the matching funds for the curriculum development activities funded by the CAUSE grant.)

The four departments (Geology, Physics, Economics and Chemistry) that figure centrally in the CAUSE grant were among the top six departments in the College of Letters and Science, as ranked by the L&S faculty and evaluation committee. As such, they were allocated additional resources within a zero-based budget reallocation process. The objectives of the CAUSE proposal were based on the explicit goals and objectives of these departments, a fact cited in the proposal as evidence of a strong relationship between project objectives and locally defined institutional needs.

In general, the CAUSE project goals focused on the development of curricular alternatives, emphasizing the university's then current interest in individualization; the establishment of a resource facility (the Jackson Science Center) which included interactive computer terminals; and, the continued development of the university's planning model with which the overall project was to be integrated. Specifically, the project goals and objectives were as follows:

Goal I. Improve the quality of the institution's existing program of individualized instruction in the science areas.

Objective I.A. Establish a relatively stable complement of individualized coursework in introductory science areas and develop mechanisms through which this curriculum is routinely evaluated, updated, and revised.

Objective I.B. Improve the physical facilities and instructional support in Jackson Science Center to effectively accommodate Springs' growing programs of self-paced instruction in the sciences.

Goal II. Establish new instructional alternatives at the advanced undergraduate level that take advantage of Springs' unique academic calendar and enrich the undergraduate experience and improve prospects for post-graduate career placement.

Objective II.A. Develop and establish an undergraduate cooperative education-intern program model that is adapted to Springs University and industry in its service region.

Objective II.B. Establish self-paced alternatives in upper-level major sequences that operate more cost-effectively than traditional instructional modes.

Objective II.C. Develop and evaluate new curricular elements and teaching strategies that involve students and science faculty in extended periods of problem-focused study and/or research.

Goal III. Increase the volume and quality of academic interactive computing at all levels of the undergraduate science curriculum.

Objective III.A.	Establish a new centralized, interactive computer graphics facility in a centralized location within Jackson Science Center.
Objective III.B.	Develop and implement new interacting computing applications suitable for classroom use in the science areas.

Goal IV. Develop and evaluate a new, comprehensive program evaluation and resource allocation model to support both qualitative and quantitative improvements in the institution's undergraduate science curricula.

Objective IV.A.	Develop and evaluate a comprehensive academic program evaluation model that will effectively inform resource allocation decision-making processes within the university community.
Objective IV.B.	Implement and evaluate several resource-reallocation strategies that promise to enable academic program renewal within a "steady state" budget environment.

Information on the Site Visit

The site visitors arrived at the project with the general intent of focusing on its four major goals. More specifically, the visitors were interested in obtaining insights related to the following questions:

(1) To what extent is the unusually explicitly defined relationship between university goals and project objectives an actual and meaningful relationship; i.e., does the relationship exist in reality or only on paper?

(2) How did the planning and evaluation model work, and how did it relate to project implementation?

(3) How did the instructional development and evaluation process occur?

(4) To what extent were the proposed objectives modified and/or completed?

Because of the complexity and comprehensiveness of the project and its objectives, the team elected to split up for most of the visit, coming together for key interviews and debriefing sessions. The visitors also had the opportunity to observe the Science Center in use, to work through several short instructional programs on the interactive computer terminals and to review selected instructional materials developed as part of the grant. Approximately twenty-four 30-45 minute interviews were conducted with approximately 25 persons including the following:

- The project director, Professor of Physics;
- The Assistant Vice Chancellor for Academic Systems;
- The Dean of Letters and Science;
- Chairmen of 3 of the four departments involved (Geology faculty were not available);
- Faculty representatives involved in materials development from each of the departments except Geology;
- The Director of Testing who participated on some of the evaluation activities;
- Graduate students, who assisted in some of the evaluation activities;
- The former grants director;
- Selected students.

Description of the Project

The Springs University CAUSE project consists of the following five sets of activities:

1. The development of an interdisciplinary science center;
2. The development and implementation of courses and course materials in the areas of geology, chemistry, physics and economics;
3. The development and implementation of an internship program in the participating departments;
4. The development of computer-based exercises for use in upper division courses and laboratories;

5. The development of a general program evaluation and resources allocation model used to relate science department needs and objectives to university resources and goals.

This section of the report will describe these sets of activities.

Project organization. The project was directed by the Chairman of the Department of Physics and Astronomy. Responsibility for the accomplishment of individual project goals was allocated almost completely to four individual project staff, termed "project associates." Project associate positions were filled by professors from the areas of biology, geology, and physics, and by the Assistant Vice Chancellor for Academic Systems. (The biology professor was selected for his previous experience with similar projects.) Each of these project associates, in turn, allocated many of their responsibilities to individual faculty members. Thus, the activities of the project, and the responsibility for them, was substantially dispersed throughout the involved departments. In order to clearly present a very complex project, the following description of the project is organized around the major activities, rather than in terms of the responsibilities of the individual project associates.

The science center. The interdisciplinary science center is a pleasant, inviting area comprised of a large central room, a resource desk with extensive storage space and three smaller rooms. One, a reading room, with its collection of scientific journals appears to have the greatest density of students. The other two rooms, one of which holds a small wet lab and equipment for a self-paced biology course, are used to support specific self-paced courses. Students also work at study carrels in the large room using audiovisual equipment for individualized laboratory instruction. Most of the project's computer equipment is also kept in this room. The center is staffed by a full-time director and student assistants who check out and otherwise keep track of the reading materials, computer tape cassettes and other equipment for self-paced courses and independent study materials. The center is used as a central location for many of the materials developed by individual faculty, particularly for those utilizing computers.

Course materials. A report produced by the project lists over 125 individual instructional materials produced under the auspices of the Springs University CAUSE project. The following are listed to provide an example of the range of materials produced, most of which are to augment, rather than replace, existing courses:

- A course manual and exams, with sound-on-slide programs for an individualized course in general physics;
- A manual for an individualized field trip in geology;
- Two videotapes for an introductory astronomy course;
- A series of seven course guide manuals for special topics in upper division courses in economics;
- A syllabus and accompanying materials for three new advanced chemistry courses; and,
- Approximately 75 computer-based instructional modules in topics taught by the four departments involved in the project.

These and other materials development efforts were funded under the CAUSE project in coordination with the institution's faculty development program in which faculty proposals for curriculum development efforts were funded for additional units of 7 1/2% of their regular salary for each month of additional instructional development.

The materials are developed by the individual faculty member with little outside assistance. They are of varying quality in accordance with the skills and inclinations of the individual faculty members. Some materials are used quite regularly, others are kept on hand to be used as needed; e.g., when a student cannot participate in a regular course.

Internship programs. Springs University is located within 100 miles of a number of major industrial centers, but has relatively little industry within easy student access of the university. An intent of the project was to provide upper level students with meaningful experiences in industrial settings through intern programs in each of the departments represented in the CAUSE grant. Although a large number of corporations were contacted, relatively few showed much interest in the program. Although several students were placed during the course of the project, the internship did not achieve the success that was initially hoped for.

Project staff feel they have learned some lessons from the experience, however. Originally the internship experience was to have been only eight weeks long. They have since found that industry considers a three-month commitment to be minimal. They also found that industry felt obligated to pay interns for their work sometimes because of union requirements. This removed a hoped-for incentive for industrial support of the program, obtaining low-cost help. Another insight gained from the experience was that while industry naturally wanted to receive only the highest quality students, most undergraduate students with high grade-point averages are looking forward to graduate school and have no interest in industrial experience. Finally, many students, especially those with families, were unwilling to relocate for a short period of time.

Although the internship program was not the success initially hoped for, it will still be continued for the sake of those who do want to participate as opportunities become available.

Computer-based activities. An important objective of the CAUSE grant was "to increase the volume and quality of academic interactive computing at all levels of the undergraduate science curriculum." This was achieved through the acquisition of a variety of hardware (installed in the Jackson Science Center and, in the case of some portable equipment, in the offices of participating faculty). Included in the hardware procurred under the grant are three display terminals, a hard copy unit, a graphic tablet, and a MINC 11 graphic computer. The new computer equipment has been integrated into instruction in a number of ways. The development of individual computer-based instructional modules has already been mentioned. The availability of the equipment provided one faculty member with the opportunity to use the 7 1/2% funds to learn a computer language and computer programming so that he could develop the instructional modules. Another faculty member, a prominent chemist, used the MINC 11 as an interface between experimental laboratory equipment and the other computer terminals. Based on data collected by project evaluators, the computer equipment is being regularly used by both students and faculty and seems to have been integrated into the ongoing activities of the departments involved.

The resource allocation model and an evaluation system. The concept of resource allocation within fixed budgets discussed in the introduction to this report was to have been further developed as part of the activities of the grant. Although the concept remained an important one throughout this period of the university's history, and while it certainly played a role in this project in providing its original impetus, no actual model has been developed. Rather, according to project staff, the model has been a model in a general way--not articulated or written down, but important as decisions about resource allocations have continued to be made throughout the project.

Related to the intended resource allocation model is the comprehensive approach to evaluation which was to inform the allocation of resources. Project evaluation has been carried out by a variety of personnel and has focused on a variety of project components. Fairly informal reviews of printed materials were carried out by a faculty member with some experience in the area, a variety of "head counts" were taken on student usage of the science center and its equipment, brief descriptive reports were written by project staff about various aspects of the project. While there did not seem to be an overall coordinated approach to evaluation, a substantial amount of information has been available to those who wanted to know more about project implementation. There has been little evidence that the information has been used to make project decisions, and some evidence to suggest that much of it was collected in response to NSF's heavy emphasis on evaluation data in its original solicitation.

Summary. This project consisted of a large variety of individual components. Because of this complexity, it was difficult for the site visitors to "get a handle" on the complete project and to fully understand the relationship between its various parts. However, it also appears that many of the activities are in fact occuring completely independent of each other and that there is, in fact, little relationship among many of them. This is not in itself a criticism, as many of the individual activities seem to be quite successful. If there is a unifying theme, it is the effort to use the project as a means of capitalizing on the initiative of individual faculty members to improve the quality of instruction at Springs University by whatever means seems most appropriate to the individual. The following section discusses this and other perspectives in more depth.

Issues

Meeting institutional needs. This project was designed to meet institutional needs in the following ways:

1) It supported activities directed toward upgrading and updating the undergraduate curriculum at a time when the institution had to reorganize and retrench in order to survive.

2) It came at a time in the institution's history at which faculty morale was at a low ebb and provided incentives for self-improvement.

3) It grew out of the long-term planning process which the institution had initiated.

4) It was consonant with the developmental direction of the university both at the time the proposal was written and now.

The support which the CAUSE project provided did not alter directions. It did make things happen more quickly and more effectively than would have occurred according to the regular plans. The support provided a focus and a critical mass that would have been missing without it. The support made the resource center possible. Without external money, it is uncertain if the functional facility would have been organized.

The project is integrated into the university. It was the first major project of a curricular nature which derived from the comprehensive planning process that had been instituted two years earlier. Thus, in some ways it is a "test" of the planning model.

For the above reasons it can be said that the project met high priority institutional needs. However, it could also be said that there was, in some respects, a mismatch between project and institutional goals. The most important example of this is the project's emphasis on individualized instruction. While the project was designed and proposed at a time when self-paced individualized instruction was definitely a high-priority institutional goal, this became much less of an institutional thrust with the arrival of a new administration near the beginning of the project. Evidence of this change included the dissolution of a relatively new campus-wide center for individualized instruction, the reported advising away from self-paced programs by the university counseling staff and the minimal use by students of self-paced alternatives. Although there is still some emphasis on individualized instruction at the university, it does not seem to be as strong a priority as it had been.

Project implementation. Many materials have been developed. Moreover, the products coincide well with the proposed objectives. This is accurate especially for Goals 1-3 and the related objectives. Goal 4 is less easily assessed partly because it lacks clear definition.

In addition, the products have some promise of implementation since the developers are the users and they prepared materials which they felt were needed. However, curriculum planning occurred on two levels and not on a third, critical, level. In developing the proposal, the curriculum planning was at a high level of generality; i.e., that four departments would develop a resource center, some instructional computing, several self-instructional introductory courses, many modules and mini-courses for upper division majors, and an internship. In implementing the proposal, the curriculum planning has become highly specific, e.g., that this computer program is for processing these data in this particular laboratory activity. The missing level of generality is at the mid-level which connects the general and the specific. Thus, if the products cohere, it is either serendipitous or because a single professor developed a whole array of modules or mini-courses which were build on a conceptual framework which was internalized, and idiosyncratic, and probably not shared with others.

Thus, the products fit an implicit (perhaps, non-existent) curricular organization. This is quite typical of college curricula which usually are comprised of clusters and sequences of courses which relate to one another in rather general ways but where the content usually is not organized in logical sound patterns for effective teaching. This appears to represent a golden opportunity that was not taken. Reasons for this missed opportunity may include:

1) the project management was loose;
2) the determination of modules to be developed depended heavily on individual faculty initiation;
3) no well-planned curricular organization exists at a level of generality below the course;
4) project staff did not include instructional designers;
5) evaluation was not an integral part of the project;
6) no change agents were employed who were high level subject specialists to help faculty rethink the structure and organization of their disciplines.

The process of having faculty compete for extra salary by writing proposals and then going to their office, library, or home to write curricular and instructional materials has many benefits including the motivation of individual faculty to produce, and the increased quality of proposals through competition. However, the process also tends to reward isolationism which may be a problem at Springs. Some mechanisms should have been provided to break people loose from that isolation. Consultants, peer review, mid-level curricular planning and other actions could have helped reduce this problem.

Another sub-issue surrounds the lack of student involvement. One faculty member indicated that student morale was low. Student-faculty interaction seemed to be quite limited. No evidence of student involvement in program planning and development was available. For some courses, curriculum and module development was not considered essential. The topic is perceived to be more easily taught with a few classroom handouts and class discussion. Both the lack of student involvement and the failure to include some topics are predictable and observable at Springs. Although these phenomena may be inevitable in all development projects, the lack of mid-level planning of curricula has exacerbated this problem.

Quality of instruction. The quality of instructional materials could have been improved if instructional designers had been available to assist faculty. This was also discussed in the section on implementation in the context of reducing isolation of Springs faculty. It would have provided individuals with new perspectives on their own subject matter that would have helped to (a) improve the effectiveness of individual units and modules in meeting specific educational objectives, and (b) given a greater coherence among course components.

Product utilization seems to be modest in many cases and erratic in others. While the science center received fairly regular use, many of the curricular materials have been unused or infrequently used. This may reflect the change of emphasis on self-paced materials, a lack of adequate planning for coordination and implementation of modules, the inadequate development of certain components or some other factor. It could also be argued that self-paced alternatives need not be heavily used to be judged successful, but rather should be available for the occasional use of the student with unusual personal requirements for the pursuit of an academic career.

The project has brought several innovative practices to Springs. The internship program, the graphics terminals, the Science Resource Center, and the use of computers such as MINC 11 in conjunction with laboratory equipment as a data gatherer and processing device are all a direct result of the project. Moreover, without the CAUSE project, some, perhaps many, of the innovations would not be in place. Quite clearly, the MINC 11 and the resource center would not be present and these may represent the most significant entities that result from CAUSE since they both are critical to development of a high quality upper division program because they will tend to reduce parochialism, allowing and encouraging students to read more journals about research at other institutions and to do more laboratory work that is characteristic of larger institutions.

Evaluation. Evaluation was given a heavy emphasis in this project. The university-wide planning process, which provided a foundation for this project, includes regular feedback loops. Objective IV.A. relates to the development and evaluation of a program evaluation model which will inform resource allocation decisions within the university's planning model. Additional evaluation strategies are either expressed or implied by most of the other objectives in the context of the development and/or improvement of instruction.

A wide variety of evaluation activities were actually carried out in the project. At least seven different persons conducted evaluations related to the project's objectives, resulting in at least eight detailed formal evaluation reports. In addition, curricular materials were evaluated by project staff prior to final production. This level of emphasis on self-study is unusual and commendable.

In this writer's opinion, however, the evaluation process had some problems. In spite of all the evaluation-related activity, there seemed to be little impact of the evaluation data on the project. At times this seems to have been due to the wrong questions being asked or the right questions being asked too late or too superficially. An example of this was the regular evaluation of developing curriculum materials. The 20-minute cosmetic-oriented once-over given to the materials in next-to-final draft form does not allow for early student input or for the input of most of the other types of formative evaluation data that could lead to the improvement of draft materials. Another example was the attempt to apply classical research design techniques to the early evaluation of materials usage. The person in charge of this activity was justifiably frustrated in this regard, primarily because the structure of the project did not match the assumptions necessary to conduct such studies (e.g., a comparison of the previous approach to the new in terms of student outcomes). Either classical research design strategies should have been abandoned from the start, or the project should have been designed to support this sort of controlled investigation.

There also seemed to be a problem with coordination and communication of evaluation activities. With a few exceptions, only those persons directly involved with the conduct of the evaluation seemed to be aware of or concerned with the use of evaluation data. Even then, there seemed to be limited awareness of what others were doing regarding evaluation. In spite of all the resources expended on evaluation, it was not on the tips of tongues of those we interviewed. It was rarely, if ever, referred to without specific prodding. Even with prodding, many project staff were unable to describe how evaluation activities related to what they were doing or decisions that would have to be made. While the project's associate director did pull the various evaluation studies together in a cohesive and comprehensive final evaluation report, there seemed to be little evidence that feedback to project participants occurred on a regular basis or that the data were in any way used to improve the program as it progressed.

In summary, it appears that the project could have profited substantially from the development of a more explicit and commonly perceived rationale for all evaluation activities, particularly with respect to the relationship between data to be collected and specific decisions to be made by various project staff. Most of the necessary ingredients for an extremely comprehensive and useful evaluation seemed to exist, but the project fell short in coordinating these into an overall project evaluation system.

Spruce College

General Background

Focus: Individualization of course materials for Chemistry, Biology and Mathematics

Budget: From NSF: $38,100
From Institution: $20,412

Began: June 1977

Duration: 12 months

Date of Visit: November 19-20, 1979

Visitors and Report Authors: Richard Lent and Jacquelyn Beyer

Spruce College is a state-supported community college serving a community college district in the southwestern United States. The region served by the college consists of a high, arid plateau dotted with small towns (none larger than 8,000 people) and three Indian Reservations. Founded in 1973, Spruce College provides the only post-secondary education services in an area of 21,000 square miles and 110,000 people.

Spruce College stresses a commitment to providing a wide range of educational services to an ethnically, culturally and educationally diverse population. It is also committed to providing these services within a short driving distance of any student's home. This orientation has guided the college's development within a decentralized campus concept. At the present time, Spruce College enrolls 4200 students (1400 FTEs) in offerings at 33 separate facilities throughout the region. Rather than having the students travel, the faculty members do the traveling and it is the norm for a faculty member to travel 60-100 miles in a day to offer courses at two different locations.

The college has four major centers in Homer, Winston, Painted Bluffs and the Pine Mountain area which serves the towns of Wild Card, Brookside, and Treeline. These centers are connected by a shuttlebus service and constitute mini-campuses with instructional facilities and support services housed (typically) in a cluster of prefabricated buildings. Other centers are smaller in resources and enrollments and may be based in temporary rented facilities. In spite of its small size and unusual instructional circumstances, the college operates efficiently, having the third lowest cost-per-student among the state's higher education institutions.

Over 30 full-time and 300 part-time faculty offer a full complement of college-preparatory, vocational/technical and self-improvement courses. The demands placed upon the faculty's instructional activities have led to the adoption of some innovative practices. Specifically, while group instruction is still widely utilized, many courses are now (as a direct or indirect result of CAUSE funding) offered in an individualized instruction/mastery learning format. As used at Spruce, this approach not only enables faculty to adapt the course to fit the varying backgrounds of the students, but also lets them offer more than one course at a time. Thus, during certain periods a Spruce College classroom may resemble a modern version of the one-room schoolhouse with a class comprised of students working on several different courses (in the same subject area) with one instructor. In addition to individualization, a few courses are available in more than one instructional medium which enables them to overcome some differences in student learning styles and study skills.

From Spruce College's earliest days, the college's administration has given considerable verbal support to the need for developing innovative instructional means for delivering courses. Other agendas were more pressing, however, and it was not until the time of the CAUSE project (coinciding with some important personnel changes) that innovative instructional practices began to receive some support and attention. The CAUSE project director (who is also Chairperson of the Physical Sciences and teaches chemistry and geology) came to Spruce in 1975 and immediately confronted the problems associated with a limited number of students, dispersed classrooms and the need to provide more courses than the available resources could support. At about this same time, he learned of the new CAUSE program and submitted a proposal for a project to help overcome these problems. That first proposal was rejected but, using the feedback received from NSF reviewers, the project director and another faculty member revised and resubmitted the proposal the following year. This time it was successful and the college received $38,100 for a one-year project to accomplish the following objectives:

a. To improve education in the physical sciences by providing tutorial materials to improve critical thinking ability of students.

b. To provide tutorial materials to help students acquire a basic knowledge of the subject.

c. To enrich the content of the geology courses through use of local geology and resource development, discussion and field trips.

d. To develop a reference collection of local flora and fauna for use in forestry, range management, ecology, botany and zoology courses in specific two-year programs that the college is developing.

e. To develop new modules, and review and revise previously prepared modules that are used in lieu of an instructor in centers where there are not enough students to offer a conventional class. (Proposal pp. 4-5)

Information on the Site Visit

The site visit team flew into Winston in a small twin-engine plane on a Sunday night just before Thanksgiving. Both of us had been to other CAUSE projects within California's higher education system and the contrast between those institutions and Spruce College in terms of resources, size, student demands and faculty expectations was great. On the basis of the proposal and brief telephone conversations with the project director, it had been difficult for us to develop any specific agenda or focus for our visit. We were interested in seeing what a relatively small, short-term project could accomplish. In addition, we were curious as to the nature of the institution we were visiting and wondered just how much of it we would get to see.

On Monday morning, the project director met us for breakfast at our motel. After discussing the project for an hour over coffee, we drove out to Spruce College's Winston campus on the far side of town.

The buildings of the Winston center sit on the prairie like a wagon train encamped for a break. The six or seven single story structures are arranged in a circle with a grassy "quadrangle" in the center. It was obviously a new facility and efforts to add some landscaping to the campus had just begun. Each building was actually a small prefabricated house, but the structure had undergone substantial modification to meet the college's needs. Typically, a door in the middle of the building led to classrooms at either end separated by a central cluster of office and storage space and/or bathrooms. The building that was the project director's Winston base had a standard classroom at one end and a biology/chemistry laboratory at the other. In between these two rooms was his office which was largely devoted to the storage of instructional supplies for biology, chemistry and other sciences.

Spruce College is actively working to spread its resources as evenly as possible across its major centers and has established a policy of dispersing its faculty as well. Thus, while the project director is based at Winston, other CAUSE project faculty are based at Homer and Wild Card. In the course of a typical week, each faculty member's instructional responsibilities bring him in contact with other project faculty, but faculty communication definitely requires some planning. For us to meet all members of the project in two-days' time, we would have to travel to meet them. Therefore, after a brief look at the Winston facilities, the project director obtained one of the college's cars and set out with us for Homer and Wild Card.

We reached the Homer center after a 45-minute drive. The physical facilities at Homer are much like those at Winston, only here the faculty had more control over the design of the science building and had created a facility better suited to the kind of independent study/concurrent course offering approach to science education that is now in use at the college.

The CAUSE project's biology faculty member met with us at Homer and explained the logistical and instructional procedures used to offer an independent study course in biology at more than one instructional location under conditions in which the same instructional space has to be used by chemistry and other science courses. At the time of his hiring, the biologist said that an interviewer had asked him, "Can you teach biology out of a shoe box?"

From Homer, the project director took us on another 40-50-minute drive to Wild Card where we met the project's mathematics faculty member. The mathematician, in one sense, had been the project's most productive member, having adapted commercial materials and written study guides and tests for 14 different courses in six weeks of release time. He impressed us with his knowledge of sources of existing instructional materials by recognizing our potential familiarity with Syracuse University and asking about the individualized calculus course offered there.

After spending some time talking to several students, we rejoined the project director for the 90-minute ride through an early snowstorm back to Winston. As in the other parts of the day's travels, we discussed various aspects of the project with the project director. The discussion during this particular drive focused on the project staff's experiences in using locally-prepared videotapes to substitute for live lectures in chemistry.

The next morning, back at the Winston campus, we were able to view some of the chemistry videotapes. We also interviewed a member of the English faculty who had individualized his courses, an academic counselor to the students, a biology instructor who was not part of the CAUSE project, and several students. We concluded our visit with an exit interview with the project director at a local Mexican restaurant near the Winston airstrip.

Description of the Project

The plans for this one-year project underwent revision almost immediately on receipt of the grant. As outlined in the proposal, the initial plans were to begin the project in the late spring with each of three project faculty reviewing the current status of their courses, clarifying their objectives, setting priorities upon necessary instructional resources and searching for commercially available materials. During July and August, the faculty would then have six weeks of release time to design or collect their resources (field trips, experiments, speciments, etc.), develop study guides and exams, and incorporate any commercially prepared materials. The following academic year would then be used to complete the development and implementation, and evaluate the success of these new courses and materials.

The project's plans ultimately proved unworkable due to several unforeseen events. First, the notification of the grant's award was not received until June which was too late to begin the planned activities for the summer and long after the faculty had stopped hoping that they would actually receive the grant. Project plans were then further complicated by the departure of two of the project's original faculty. One of these positions was not filled until the following spring. As a result of these events, most of the year was spent in reviewing available materials and making purchasing decisions. Course development did not get underway until the project's closing months in the summer of 1978.

Responding to one of our questions, the project director described the project's activities over the year in some detail. Relatively little occurred during the first summer except that the project director spent about two weeks handling administrative details at the college and writing to various commercial suppliers for information on their materials. In the fall, he requested materials for review from the commercial sources, ordered video equipment, went to the CAUSE project directors' meeting (which he found quite helpful) and made his first chemistry videotapes.

During the spring, the project director and new biology faculty member were released from half of their regular duties to design and install the new laboratory facility at Homer. (This activity was supported by the college and not directly related to the CAUSE grant.) The project director and the biologist were then joined by the new mathematics faculty member in spending some time that spring reviewing existing instructional materials for their courses and touring institutions with exemplary individualized instruction programs. Specifically, the project director spent a week touring six California colleges which were using programmed instruction materials in biology, chemistry and math. The biologist made a similar series of visits to colleges in Oklahoma and Nebraska, and the mathematician toured programs in Texas. The institutions they visited had been identified through a review of various publications on ERIC (the National Institute of Education's Education

Resources Information Center), inquiries made by the college's president, and a series of telephone interviews. CAUSE funds covered about two-thirds of the expense of this series of trips which, reportedly, were quite helpful to the project faculty's deliberations. (This reconnaissance effort was in addition to the project's original set of planned activities.)

Finally, during the summer of 1978, all three of the project's faculty members devoted from six to eight weeks of full-time effort to developing their courses. An audiovisual production specialist and several other people assisted with the preparation of materials, specimen collections, etc. Under the CAUSE grant, the mathematician prepared study guides and tests and modified the commercial materials as necessary to individualize two math, three algebra and two calculus courses; the biologist completed similar instructional development tasks and prepared collections of local biotic specimens for five biology courses; and the project director/chemist completed materials development activities (including forty one-hour videotapes) and field trip plans for four chemistry and geology courses. While the CAUSE project technically ended that summer, project faculty have continued to revise and to add to their course materials. In the project director's opinion, the CAUSE project enabled the college to speed up the development of its science program by three years or more.

Outcomes. We arrived at Spruce College a year and a half after the CAUSE project ended. It was now possible to ask faculty to look back upon the project, summarize their accomplishments and assess the resulting strengths and weaknesses of their efforts. Each area of project activity (mathematics, biology and chemistry as well as the project's overall management) was considered in turn with the faculty member involved.

In biology, the faculty member emphasized that the CAUSE project enabled him to do in one year what he would not otherwise have been able to do in that time: create a totally individualized system of instruction in biology. This new system made it possible for him to conduct several courses simultaneously at a given center. He had two complete sets of instructional materials -- one in Homer and the other in Wild Card. With these materials he was also able to offer courses alternately in Painted Bluffs and Winston. To save money these courses had been largely based upon commercial materials from Purdue University, but the CAUSE money had specifically enabled them to produce their own set of professionally recorded audiotapes. (These tapes were modifications of the original Purdue scripts which depended upon the existence of a specific array of learning carrels not feasible at Spruce.)

The biologist explained that he felt that the individualized materials had proved to have a number of advantages: they lessened the course's reading demands (due to the audiotapes); they permitted more flexible pacing; they removed the need for three to four hour-long lectures once a week; they made it possible to spend class time in one-to-one tutoring; and they enabled the instructor to use a kind of mastery learning approach that improved student success rates. While he noted that some students do not like the system, their attitudes usually change over time and they are losing only 20% of their students each semester. In short, he felt that their system of individualization had helped the college to successfully overcome instructional problems arising from the poor preparation of its students and the complications of a multi-cultural population consisting of three tribes of native Americans, Hispanic-Americans, blacks and whites.

The mathematics faculty member explained his view of the impact of the CAUSE project in terms of increased course offerings: "The previous math instructor had restricted the course schedule to two or three small groups with more limited course offerings. With these materials [from the CAUSE project], we can offer the full catalog of course offerings. We are not restricted."

The mathematician has continued to work on the individualization and general refinement of the math courses. During the fall semester of the site visit he was teaching 18 students in his evening section and 14 in his day sections at Wild Card, and 16 in his White River section. In all, these 48 students were enrolled in eleven different courses. Within very broad limits, all mathematics courses now have open entry and open exit possibilities: about 20% of the students begin their course(s) as much as three to four weeks after the formal beginning of the semester while another 20 % of the students finish their courses before the regular semester ends. Testing and grading is based on mastery learning principles and multiple versions of every test are available so that students may make two or three attempts to achieve the desired standard of performance.

The mathematics faculty member is a strong supporter of individualized instruction. He has found that once his students have experienced this form of instruction they generally would not prefer to return to traditional lecture-based courses. Specifically, when he once tried offering sections of one mathematics course (with separate lecture-based and individualized sections), he could not get enough students to enroll in the lecture-based section to make it worth offering.

Looking at the project as a whole, the project director stressed its contributions to increasing the accessibility and efficiency of the college's programs. While an individualized approach to the delivery of instruction had always been talked about at the college, the idea had not been realized until the arrival of the CAUSE project. Individualized courses are now available in English, guided studies and music in addition to the sciences. The project director specifically noted his impression that recent increases in college enrollments have been partly due to the availability of individualized courses. Individualized courses are also helping to lower the unit costs of instruction (an important mandate from the state).

In terms of his own efforts to individualize the chemistry courses, the project director's experience under the CAUSE project has been less successful than that of the other faculty members. The individualization of the chemistry courses was to be based upon specially prepared videotapes of his lectures. CAUSE funds helped to provide the equipment, materials and time necessary to prepare 40 one-hour videotapes. Care was taken to utilize the properties of the medium to best advantage including background music, titles, graphics, etc. The resulting programs were instructionally adequate if not professional in their appearance. Unfortunately, the project director has now found that about one in 10 of his students can successfully complete a course using these tapes. He believes that the students are simply not motivated or cannot maintain the necessary concentration to learn from these tapes. At the present time most of the television equipment sits unused, but the tapes are available for students who want to use them or need to make up for missed lectures, etc. (During the previous year one student had successfully completed chemistry using the tapes in place of attending lectures.) Overall, the project director now believes that while the individualized instruction system is realistic and appropriate given the college's constraints, a more traditional lecture-lab approach is still the best suited to chemistry courses.

From a project management point of view, the project director noted a number of things he would do differently were he to attempt this kind of project again. "We underestimated the size and cost of this project. If I ever did it again, I would put in for a two-year time period so that I could get the revision time needed and have at least two summers for development work. I still think the original plan was good and if we'd known in April or May that we were going to get funded we could have done it as planned. I don't know whether this would have changed the project's overall impact, but it would have helped us to improve the quality of the materials." The project director also noted that he probably would not apply for any more grants in the future as he had too many difficulties in managing the project's funding with the college's administrators. (However, other faculty are applying for grants and the college presently has a two-year ISEP grant.)

Issues

Institutional need. There can be little doubt that the individualization of instruction was a high priority need at this institution but the specific need for CAUSE support was relative, not absolute. That is, everyone interviewed at the college as well as the president in his annual report (1979) stressed the necessity for courses designed around principles of individualized instruction as the means by which the college could effectively and efficiently serve its clientele. This point of view has been borne out by the college's experience over the last several years with those courses that have been individualized. The role of the CAUSE project in addressing this need, however, was a relative one in that the need applied to all academic programs and not just the sciences; and furthermore, the college appears likely to have eventually supported this activity on its own--CAUSE simply enabled it to happen faster. Overall, however, considering the small size of this project and its unanticipated role as a catalyst in getting individualization efforts moving, the project would have to be judged as very worthwhile and cost-effective.

Implementation. The major variables in this project's implementation had to do with timing. First, the original design of the project was heavily dependent upon faculty being able to conduct a full set of course development activities during the first summer. The experience of other CAUSE projects suggests that this would have been unrealistic even if the funding notification had been received several months earlier: it simply takes a lot of planning, data gathering and organizational time to get a project rolling. In the present project it seems likely that if it had followed its original timeline, the project would have lost valuable materials and information-gathering opportunities (such as the tours of other colleges' programs), and the quality and efficiency of the faculty's development efforts might have been diminished.

A second time-related variable in this project's implementation was simply its duration: one year seems to be too short a time in which to conduct a multi-faculty, multi-course development effort. A project of one-year's duration has little room in which to adjust its schedule to unexpected contingencies. In the present case, the project lost two-thirds of its original faculty and it is thus remarkable that the project was completed in anything close to its original schedule. As it was, project faculty were unable to complete the evaluation and revision activities they had originally planned. Again, the experience of other college's development projects suggests that it is advisable to space the planned activities of any development effort out over at least a two year period.

Quality of instruction. While it is difficult to say whether the quality of the courses themselves improved as a result of this project, the number and accessibility of the college's course offerings in biology, mathematics and, possibly, chemistry did increase. Comments by faculty, college staff and students also suggest that the instructional methods of these courses are better suited to the nature of the student population. Particularly in the mathematics courses, it appears that the combination of individualized instruction and mastery learning techniques is helping more students to complete their courses with a greater degree of success.

Summary

Spruce College's project presented an opportunity for the science faculty to implement an idea that the college had held for some time: individualized instruction. With a small grant and short time frame three faculty in chemistry, mathematics and biology were able to redesign existing materials and purchase new ones to individualize a significant portion of the college's science and mathematics offerings. Individualized instruction is an important innovation at Spruce not only for pedagogical reasons, but also because it provides the only feasible means of offering a full complement of courses at the college's various instructional centers. Work on the individualization of additional courses has continued since the expiration of the CAUSE grant.

Sycamore Community College

General Background

Focus:	The development of, and retraining of faculty in a new curriculum in computer science
Budget:	From NSF: $28,540 From Institution: $15,509
Began:	September 1977
Duration	15 months
Date of Visit:	December 18-19, 1979
Visitors and Report Authors:	Ramesh Gaonkar and John D. Eggert

Sycamore Community College is a two-year comprehensive community college which offers associate degree programs in liberal arts, business, engineering technologies, and allied health. The programs are designed to meet community needs and serve approximately 18,000 (10,000 full-time and 8,000 part-time) students.

The college endeavors to provide a broad range of post-high school educational opportunities to students of widely varying intellectual abilities, background and interests. Furthermore, the college operates under an open admission policy which necessitates the offering of preparatory courses for students who are inadequately prepared to undertake college studies.

The primary emphasis of the institutional mission is on teaching. The faculty devote almost all of their time to teaching and to activities related to teaching. Faculty members are not expected to do research or to publish, although a few do undertake research activities or publish papers on their own initiative, in addition to fulfilling their full time teaching responsibilities. The curriculum decisions relating to changes in curriculum, new course offerings or new programs are primarily initiated, decided upon, and directed by faculty members. Administrative involvement in curriculum activities is generally limited to budgetary considerations and overall policy matters.

In recent years enrollments in computer-related majors have increased substantially while enrollments in the mathematics major have declined. This shift in enrollment has occurred for many reasons, one of which may be the technological changes in the computer field. In the past the demands of the computer field emphasized mathematical skills with a secondary background in programming. Now the emphasis has changed to computer systems and concepts with a secondary emphasis on mathematics, science or business. In response to the changing needs of the computer field, the departments of Mathematics, Statistics and Computer Processing decided to upgrade course offerings in the computer area. Since it was felt that an improved curriculum in computer-related areas would create an even greater load on the already overburdened computer processing faculty, and since mathematics enrollments were on the decrease, it was decided to create a faculty development program to retrain mathematics faculty to teach computer related courses, particularily at the introductory levels. The specific objectives of the project are as follows:

-To revise the computer related course offerings and curriculum;

-To retrain faculty members with backgrounds in mathematics to teach the basic computer course;

- To articulate the curriculum to meet the needs of local industry and the prerequisites of bachelor's degree requirements of four-year institutions.

Information on the Site Visit

The activities of the site visit consisted primarily of a series of interviews with the project director and faculty and staff involved in the project. We also reviewed materials used to support the faculty courses, the final report, and other project documentation (e.g., the proposal to NSF, and a proposal to the College Curriculum Committee).

The purpose of the interviews was to expand upon and clarify the activities described in the original proposal and to determine the impact the project has had on the curriculum and the retrained faculty members. We interviewed the following persons:

- The project director and Professor of Mathematics;
- The Mathematics Department Chairperson;
- The Dean of Instruction;
- The Academic Vice-President;
- The faculty trainer/course developer and instructor of mathematics;
- A faculty course developer and Professor of Mathematics and Computer Science; and
- Five representative faculty trainees from the Mathematics Department.

Description of the Project

The project consists of three major sets of activities: curriculum revision, faculty retraining and liaison with industry and colleges.

The total mathematics, computers and statistics curriculum was analyzed, revised and then implemented. As a result, courses having duplication of content were either eliminated, merged or revised. Two new degree programs leading to an associate degree in information processing and an associate degree in statistics were developed. One new mathematics course is presently being offered.

The curriculum revision activities actually began several years before the grant award with informal discussions within the respective departments becoming formalized through the college's official curriculum revision and approval process. This process included the normal series of official and unofficial negotiating sessions among representatives of the departments involved, but also included the active solicitation and analysis of input from local high schools, colleges and industries. The formal outcome of these curriculum development activities was a comprehensively documented 130-page curriculum revision proposal submitted to the university's curriculum committee. In an unprecedented move, the committee unanimously approved the entire proposal, citing it as the most comprehensive and highest quality curriculum revision proposal it had ever encountered.

A faculty retraining course was offered to mathematics faculty in the fall semester and again in the spring semester. The retraining course, taught by a faculty member with a background in computers, was primarily concerned with the basic concepts of the computer. Its purpose was to train mathematics faculty to teach the basic computer course, the content of which is more or less similar to the college's previously existing basic course in computer fundamentals. In addition, outside guest lecturers were invited to discuss computer-related topics.

Eighteen faculty members attended these retraining sessions and, in the following year, six faculty members out of these 18 trainees accepted the assignment to teach the basic Introduction to Computing course. The participants gave overall high ratings to the content and the instructor. However, fewer than half of the participants stated they felt adequately prepared to undertake the teaching assignment after their one-semester introduction to the field. (The project director pointed out that this uneasiness could be considered normal, given that the faculty were embarking upon an entirely new teaching experience.)

As a preparatory step towards the curriculum revision, the local industries and four-year colleges were contacted through questionnaires. Information obtained from these questionnaires was used to modify and develop curricula and courses. In addition, these information gathering activities served the purpose of establishing and strengthening lines of communication with other institutions. College faculty have become more familiar with the curricula of the four-year institutions most commonly attended by Sycamore graduates and are thus able to better advise and instruct those students intending to obtain a four-year degree elsewhere. Contacts with industry also have provided information on the availability of jobs for Sycamore graduates.

Although there is no indication that the specific training of faculty to teach the basic computing course will continue after the termination of the grant, it seems likely that the liaisons with local industry and four-year institutions established and/or strengthened through the grant activities will probably continue. Also, a series of other faculty training sessions in computer-related areas has been initiated by the college, the first time in 10 years any such seminars have been offered by the college. The project director attributes the initiation of and interest in these activities to the success of the NSF CAUSE project.

Issues

Institutional needs. Community colleges, in general, are charged with a responsibility to meet the instructional needs of the community. The emphasis is on teaching community residents what they need to know; research activities are incidental. From this perspective, the three objectives of the project reflect the needs of the college; i.e., they directly relate to maintaining a match between what is taught and the demands to be made on the college's graduates.

The project objectives have had very high priority from the faculty (departmental) standpoint. The faculty members have felt that the problems stated in the proposal were critical to maintaining high quality programs. The task of undertaking the entire revision of the existing curriculum and of retraining the faculty needed some outside impetus and the CAUSE project provided that support. Without such support it is unlikely that these needs would have been met in a short period of time.

The project objectives appear to be integrated with institutional objectives. Even though there is no clear evidence of active interest and involvement in the project by the college administrators, the project objectives are responsive to changes in computer technology and its impact on instructional offerings. Furthermore, the various new degree programs and certificate programs implemented by the department as a result of the project appear to be in tune with the overall philosophy of the college and with community needs.

The curriculum revision activities have been completed, at least for the near future, and will not require large resources to continue. However, the activities related to the faculty training will need the ongoing commitment of administration and/or faculty. The faculty members were retrained to teach the basic course in computer fundamentals through one inservice training course. This training seemed to be barely sufficient for them to be comfortable in front of the class even though they are assigned to teach only the basic course in computers. However, no administrator showed any concern about the problem or expressed any ongoing commitment to the issue of faculty retaining. From the comments we received, we inferred that faculty training activities of this concentration will not be continued unless some additional funds are made available from an outside source.

Project implementation. The project was primarily concerned with three objectives: curriculum revision in the area of computer science and data processing, retraining of faculty and improving liaison with local industry. It appears that all these objectives were successfully met.

The process of curriculum revision was underway even before the CAUSE project; however, the CAUSE project gave the necessary impetus to focus the efforts of various faculty members to complete the task. The unique and impressive aspect of the curriculum revision was the concept of a core course in elementary programming techniques offered as the prerequisite to all the computer courses for such various groups as liberal arts, data processing, information processing and computer science.

The inservice course appears to have been well-received by the participants. However, there was no evidence of the systematic development of such a course. The course taught to the trainers appears to be very similar to the course taught to students in previous years except that there was the addition of material on teaching techniques and a heavy use of guest lecturers.

The CAUSE project at Sycamore seems to have been well managed. The communication among project staff, faculty members, and immediate administrators appears to have been open. The faculty members in the mathematics, computer science and data processing disciplines are knowledgeable about the project activities and appear to have positive attitudes toward the project. The project is so well integrated within the departmental operation that there is hardly any differentiation between project staff and non-project staff. One of the primary reasons for successful implementation was the merger between the Mathematics Department and the Data Processing Department which took place prior to the CAUSE project. The merger was essential to the development and implementation of new curricula and was helpful for faculty retraining. It also served to establish the various lines of communication necessary to carry out the project.

Quality of instruction. The impact of this project on instruction is difficult to assess because of its emphasis on faculty training and curriculum development. Furthermore, no direct evaluation activities were conducted to gauge the impact of the project activities on instruction. However, it is possible to discuss the short-term potential impact based on conversations with faculty members. Some speculations can be made regarding long-term impacts.

The inservice training program addressed the immediate problem of preparing some faculty members from mathematics backgrounds to teach the basic course in computer science. Thus, it appears that on a short-term basis the project was successful in solving an important problem at the institution. In some ways, this is more of an administrative than a substantive issue. The improvement in instruction can be claimed only on the basis that the computer course was made available to a large number of students. However, this argument does not address the issue of the quality of instruction in the classes to be taught by novice instructors. It appears that instructors were not given all the instructional support that could have been provided, e.g. assistance in the form of written objectives, instructional material and assignments.

Inservice training in one course may be adequate to solve the immediate problem; however, it is inadequate for an instructor to be fully qualified in a new field. Various instructors spoke about their inadequacy and uneasiness about going in the classroom. Additional preparation or inservice training is apparently left entirely to the initiative of an individual instructor.

The project activities concerning curriculum development and improved liaison with local industry and colleges have apparently led to an improved curriculum, as it appears that the changes are complementary with industry needs and with curricula in four-year colleges.

Evaluation. The formal evaluation activities on the project consisted of pre- and post-knowledge tests administered to faculty trainees at the beginning and the end of each administration of the course and an attitude questionnaire also administered at the end of the course. As to be expected in a course focused on basic technical material, the data showed that faculty indeed learned much of the course content. The data also showed that attitudes toward the course and toward computers were positive upon completion of the course, although some faculty did express uneasiness about teaching it themselves.

While the activities formally labelled as evaluation on this project may be useful, at least to serve as a "red flag" indicator of severe problems, they are certainly not comprehensive. Fortunately, the project also collected information through activities apparently not considered to be part of project evaluation by the staff. For instance, the formal review and unusually strong endorsement of the curriculum proposal by the university's curriculum committee provides evidence of its quality. The needs assessment activities by which data were collected about the contexts to be entered into by Sycamore graduates provided the project with important information upon which meaningful curricular decisions were based. Input from faculty participants was solicited and responded to during the course of the project to insure the ongoing course met participant needs. Thus, while the project activities formally identified as evaluation are deficient, important and effective evaluation activities have been carried out in the context of other aspects of the project.

What is missing in the project's internal evaluation is a focus on the link between faculty training and student learning. It is difficult to determine if the content of the faculty course was what was necessary and sufficient to enable a newcomer to the field to teach the course, and it is difficult to determine if the students of the newly trained faculty are leaving the course better or worse equipped to deal with computers than if other options had been used. Although the intuitions of faculty and the normal feedback from students will supply some of this information, the apparent risks of using faculty who are themselves newcomers to the field to teach an introductory course demand that the impact of the approach be well understood.

Summary

The Sycamore Community College CAUSE project focused on the development of a new curriculum to accomodate changes in student interests and the nature of the industrial and educational contexts Sycamore graduates face. It also addressed the local problem of having too many mathematics faculty and not enough faculty who could teach the basic computer course by retraining mathematics faculty. The new curriculum was accepted by the college's curriculum committee and is now operational, and retrained faculty are presently teaching the basic computer course. Overall, the project appears to have been well managed and efficiently executed.

University of the River

General Background

Focus: Bioscience instructional laboratory

Budget: From NSF: $250,000
From Institution: $220,058

Began: July, 1977

Duration: 36 months

Date of Visit: November 29-30, 1979

Site Visitors and
Report Authors: Jane G. Cashell and Marvin Druger

The University of the River is the oldest state-chartered university in America and was founded in 1785. The campus covers a large area. There are many lovely buildings, among them the buildings which formed the original campus. The university is proud of its history and its tradition. During the last thirty years activities of the state and of the university have focused on making the institution a nationally-recognized, educational leader. Academic departments have been upgraded and expanded and faculty members have been brought in from all over the country. Some new departments have been added. Currently, the University of the River serves approximately 16,000 undergraduates and 5,000 graduate students.

One activity to improve the university is relevant to understanding the background of the CAUSE grant. At one time, biological science research was not a strong area at River. In 1965, the university received a six million dollar grant to create a Center of Excellence in biological sciences. During the next six years, research and graduate education grew and changed radically. However, undergraduate education was not able to keep pace with these changes.

In 1975, an external review committee evaluated the research and teaching of the biological science division at the University of the River. Teaching at the undergraduate level was judged to be of poor quality because of, in part, the wide range in student abilities, backgrounds, and goals. In response to the External Review Committee's study, a committee of departmental representatives from the biology division was formed to assess the situation. Their deliberations created an information base which led to the writing of the CAUSE project proposal.

The CAUSE project was intended to provide alternative approaches to working with individual student differences. A Bioscience Learning Center (BLC) would be established so a variety of instructional materials could be made available to students in undergraduate biology courses. The staff of the Bioscience Learning Center would assist biology faculty members in selecting and/or preparing instructional materials, media, and tests. Regular, remedial, and advanced instructional materials would be available for undergraduate biology courses.

Specific project objectives taken from the original proposal are listed below:

1. To provide a permanent facility for individualized and group instruction utilizing teaching centers equipped for audio-tutorial, and television-assisted instruction.
2. To develop and evaluate instructional materials for introductory biology courses for use at three levels within these courses--regular, remedial and advanced.
3. To provide materials and expert assistance in the preparation of instructional materials for use in undergraduate science courses throughout the biology division.
4. To assist in preparing and analyzing of tests in cooperation with instructors of bioscience courses.

5. To evaluate undergraduate biology instruction and interpret the evaluations through individualized plans for the improvement of instruction.
6. To disseminate instructional materials developed at the Center within the university system.
7. To initiate an annual conference in the university system dealing with instructional problems and procedures in biology.

Objectives five, six, and seven were dropped prior to the beginning of the project because of a request from the CAUSE program office to do so.

Information on the Site Visit

We conducted several activities as part of our site visit including touring, observing, interviewing, and reviewing. We toured the Bioscience Learning Center and a room which contained a television studio and an audio-visual production area. We observed one of many of the videotapes in use in the BLC. Interviews were held with administrators, faculty members, BLC staff, and a student. We interviewed the following people:

-Project director and Assistant Professor of Biology (promoted to Associate in 1980);

-Associate Project Director and Professor of Science Education;

-Director of Micrpbiology Laboratory Instruction and instructor of the course, Introductory Microbiology;

-Director of State Science Fair Programs and instructor of the course, Medical Mycology;

-Instructor of Introductory Biology (Bio 101), a course normally taught by the project director;

-Professor and Head of the Genetics Department;

-Dean of Arts and Sciences;

-Chairman of the Division of Biological Sciences;

-Associate Professor of Biology and instructor of Biology for Elementary Education Majors;

-Associate Professor of Science Education and instructor of Biology for Elementary Education Majors;

- Associate Professor of Biology and instructor of Introductory Biology (Bio 102);
- An undergraduate student; and
- BLC staff members.

Our tour and interview schedule was initially established by the project director. We asked him to make appointments for us to interview him "as well as faculty and staff on the CAUSE project, possibly some science faculty who are not part of CAUSE, some students, and university administrators". We did not specify whom precisely we wanted to interview either by name or job title. When we arrived at the University of the River, the project director and associate project director had arranged for us to interview the microbiology instructor, the medical mycology instructor, the Dean of Arts and Sciences, and Chairman of the Division. The additional interviews were arranged based on recommendations from the project director and associate project director and on requests from us. We worked fairly closely with the project director during our visit.

Before starting our site visit, we reviewed the proposal, established a focus for the visit, and discussed our personal reactions to the proposal. The focus of our visit was two-fold. First we wanted to get updated on the project. We needed to know what activities had been completed and what had not to date. Our second goal was to understand in detail, beyond that contained in the proposal, how the project functioned. We assumed that project activities had shifted and changed slightly in order to get the "ideal" project of the proposal accomplished in the real world.

We felt that the proposal described a comprehensive and ambitious project. We had a concern about the 32 faculty members listed in the proposal as committed to use the BLC because it seemed like a large number of faculty to have involved in a CAUSE project.

Description of the CAUSE Project

This CAUSE project serves and is housed in the Division of Biological Sciences at the University of the River. The division consists of the Departments of Biochemistry, Botany, Entomology, Microbiology, Zoology, and a newly established Genetics Department. Each department has its own head and the division is led by a chairman.

The overall goal of the CAUSE project is to increase instructional resources for faculty members and students throughout the Division. Resources include the Bioscience Learning Center, production facilities to create instructional materials for the BLC, a library of commercially-prepared materials for the biological sciences, and division expertise in the preparation and use of the resources.

The project had completed its second year when we visited. At that time many project activities were complete or were underway.

The Bioscience Learning Center is completed and is in use. The BLC has 30 carrels. Each is equipped with a synchronized sound/slide Ringmaster, a television, and an audio playback machine. Six of the carrels are also equipped with video playback capacity. At the control counter students can sign out instructional materials and arrange to view particular videotapes. A staff office is located behind the counter. Instructional materials and video playback equipment are housed here and desk space is available for BLC staff. Another office off the BLC serves as the space for the CAUSE project director and associate project director to conduct CAUSE business. At the end of the grant the office will become space for the BLC director. That position will be filled by the CAUSE project director.

Remodeling of the space for the BLC went more slowly than originally planned in the proposal. In planning the CAUSE project, space for the BLC was selected in the agriculture building. By the time the project was funded some maneuvering had taken place which got the BLC a space allocation in the main building of the Biological Sciences Division. However, in order to have access to the space, a new classroom had to be built first - in the agriculture building. Additional delays in furnishing and equipping the BLC were encountered because of the university's and the state's purchasing requirements.

Production facilities for the materials used in the BLC are located in another room in the basement of the same building. A small video studio has been set up in this room. Facilities for preparation of instructional slides and audiotapes are also available.

Most of the learning materials in the BLC have been obtained from commercial sources (including other academic institutions). The project director and others have developed some audio- and videotapes. The initial project activity has been to identify and procure instructional materials available commercially. Eventually, faculty members may develop instructional materials of their own.

Instructional materials in the BLC are used as a supplement to the traditional lecture format. For example, Biology 101 runs for ten weeks and involves four 50-minute lectures per week plus a regular three-hour laboratory each week. Relevant minicourses and videotapes are made available in the lab. These are not "add-ons" to regular assignments but, rather, alternative modes for learning about specific topics.

Lecture times are adjusted to allow students to complete minicourses in the BLC.

In addition to creating the BLC, the instructional production area, and the creation of a library of instructional materials in the biological sciences, the objectives of this CAUSE project include working with faculty members on specific courses. The intent of the CAUSE project is to involve many courses in the Biological Sciences Division. The initial focus has been on the introductory biology courses. Thus far, attention on the CAUSE project has been given mainly to Biology 101-102 which enrolls more than 3,000 students per year, approximately 1,000 students per quarter. (This course satisfies a lower division biology requirement, and approximately 80% of the students taking 101-102 will not be science majors.) Biology 101 is usually taught by the project director. During the CAUSE project a temporary instructor has been hired to take over this responsibility in order to create release time for the project director.

The project director has acquired new audiovisual materials for Biology 101 and has worked closely with the instructor of the course. Another CAUSE project has provided 33 half-hour videotaped lectures which were produced for an introductory biology course. In addition, audiotapes have been produced at River and a number of commercial packages including slide-tape, slides, filmloops, filmstrips and films have been purchased for use in Biology 101.

Fourteen other courses are also making use of the BLC. Several examples of how faculty use the facility are described below.

The Director of Microbiology Laboratory Instruction teaches Introductory Microbiology every other quarter and uses the BLC for his course.

At the suggestion of the associate project director, he regularly makes tapes of his lectures. Students are required to attend the live lectures and the audiotaped versions are available in the BLC for review. Visual aids are photocopied and available in folders in the learning lab. Otherwise, the course is taught in a traditional manner involving three hours of lecture per week and two two-hour lab periods per week. Audiotapes of lectures were first made available in Fall, 1979. Evaluation data have not yet been collected on the provision of tapes and aids in the BLC. The Director of Microbiology Laboratory has been planning to make videotapes of the labs and an introduction to the lab in the near future.

The Director of the State Science Fairs Program teaches a course in medical mycology. He uses the BLC to provide reinforcement of the material presented in lecture. The color slides which accompany his lecture as well as an audiotape of the lecture itself are avaliable to students in the learning lab. The availability of these materials in the BLC is thought to be helpful to mycology students because they need to view the slides several times to learn the distinguishing features of each example. At first, his lectures were recorded verbatim. Now, he is starting to edit the tapes and add new material to them. He hopes to thus stimulate more students to review the lectures in the BLC. The instructor of Medical Mycology has said that he would not have taped the lectures if not for the availability of the BLC as a place where students could access them.

The instructors of Biology 105-106, Biology for Elementary Education Majors, have used the BLC to make an interactive videotape module on genetics available to their students. They have also conducted a study of the effectiveness of the module in the BLC. They believe the BLC may be a good place to make greater use of interactive videotapes, and they feel welcome to do so. However, they are interested in empirically verifying the effectiveness of future uses of the BLC that they might choose for their course sequence.

The associate professor of botany is the instructor of Biology 102, the second semester of Introductory Biology. Several years ago he developed a number of minicourses as part of the instructional resources for Biology 102. At present, his students use two of the minicourses in the BLC, one on photosynthesis and one on cell respiration. He also has tape-recorded his lectures and has made the tapes available in the BLC.

The project director estimates that, to date, about 25% of the teaching faculty are using the facility or are planning to do so. He thinks about 50% would use the lab if instructional materials were obtained for them so that they would not have to expend the effort of doing so. He believes another 25% will probably never use the facility because of philosophical objections to the mode of instruction. He intends to encourage greater use of the laboratory by continuing to attend faculty meetings of various departments where he will tell the faculty about services available at the BLC. He anticipates greater use of the BLC in the future as it gets established.

One of the major responsibilities of the associate project director is the organization and management of evaluation activities on the project. Three types of data are being collected on the project. Housekeeping data include records of students and courses using the BLC and the number of uses per package of materials. The data collection began when the BLC opened. The data have been analyzed for an interim report to NSF and for

reports to individual departments in the Biological Science Division. The associate project director intends to use these data to present to departmental faculty meetings to encourage and stimulate use of the lab.
He believes that the groundwork is being laid for greater usage of facilities a few years from now.

Formative evaluation involves review of the suitability of commercially-produced and BLC-produced materials, first by the project director and then by faculty members in the relevant department. Once materials are installed in the BLC, students are asked to rate the materials. Instructional materials developed by the BLC staff and Division faculty members are evaluated for content accuracy and comprehension using a small number of faculty members and students.

Plans for summative evaluation include combining student opinion data with more rigorously controlled studies of cognitive gain. An example of such a study is the one conducted by the instructors of Biology 105-106 of the interactive videotape module.

Continuation of the BLC with complete staff and services has been assured by the Chairman of the Biological Sciences Division. He has been a staunch supporter of the CAUSE project as well as an instigator of the project from the beginning. The project director also is firmly committed to the operation of BLC with university support in the same way as it functioned under CAUSE funding. He is convinced the division and the university will provide all funding necessary for its continuation.

Issues

Institutional needs. From our conversations with a small number of faculty members in the Division of Biological Sciences we got what we believe is an accurate picture of institutional needs of a large university. There is a need to provide quality undergraduate science instruction and there is a need to pursue top level research. The faculty and the university are committed to competing needs.

The CAUSE project at the University of the River is designed to provide alternative learning opportunities for students who differ in aptitude, background, and goals. There appears to be a real need to upgrade the quality of undergraduate instruction based on the External Review Committee's recommendations and the comments from the division chairman. There is no doubt that students arrive as freshmen with very different accomplishments and abilities. Both problems exist. What is not clear is what priority these problems receive from the university.

It seems that the BLC might have come into being without CAUSE funds in order to meet an important need - to better teach biology students. It is likely it would have been a very slow and gradual build-up of resources over a long period of time because the need is given less than top priority at this time at the university. The space allocation and renovations would have happened but it's not clear when or where they would have been without the clout and pressure of CAUSE funds to make things move quickly.

In terms of institutional support for CAUSE, in a larger institution it seems reasonable to look for evidence of this mid-level in the institutional structure. The division Executive Committee has provided important support as evidenced by the space maneuvering for the BLC. Support from department heads is reported by those we interviewed as being weak. There seemed to be some hints from the division chairman that his enthusiasm for quality instruction is viewed as a fault in him by some other faculty members.

Implementation. The project is meeting its objectives as outlined. There appears to be some shift in activities from producing materials in-house to purchasing commercial materials. The decision to do this was made by the project director and associate project director in order to more rapidly increase the number and type of instructional resources available from the BLC.

The planning, management, and administration of the project is very smooth and very well accomplished. The BLC appears to operate effectively. None of the faculty members we interviewed identified any problems in using the BLC, its production capability, or in working with the staff.

Implementation of this project is behind the schedule proposed in the original plan. This resulted from the need to plan academic year schedules well in advance of the time the award was made. The problem stems, in part, from NSF's time line on project awarding and, in part, from limited flexibility in rescheduling faculty loads on the part of the University. Announcement of the CAUSE grant award came after the project director and associate project director had already scheduled and been assigned to other activities for the year. Full release time, as planned in the proposal, could not be scheduled at that time. Work on the project that first year was done on an overload basis. In the second year of the project full release time was arranged as planned.

There were comments from some of the faculty members we interviewed that the project director had to undertake some responsibilities for the project that normally would have been handled by the division chairman. The beginning of the CAUSE grant coincided with the beginning of a two-year leave of absence for the chairman. His support appears to have been important for successful implementation of the project and yet the proposal was submitted just around the time he went on leave. It might have helped to keep the project more closely on schedule if he had been available to undertake some of the administrative arrangements.

In the CAUSE proposal, department heads did make a commitment to give faculty members release time to develop course materials for use in the BLC. The project director and associate project director had not organized this activity at the time of our visit. Up until that time, the facilities had not been available to do so. Release time for instructional materials development has been provided to the project director for Biology 101.

Improvement of the quality of instruction. The potential for improvement of the quality of instruction is related to two activities. One is the careful selection and evaluation of instructional materials. The second is the incorporation of the BLC and its instructional resources into undergraduate courses. As part of the CAUSE project, an evaluation system has been established to monitor the quality of materials. Actual use of these materials depends on faculty members teaching the courses. The involvement of faculty members may be a longer term effort, it appeared during our site visit.

The university has a dual commitment to research and teaching. The dual commitment places teaching faculty members in the position of needing to do both activities successfully. This does not leave a great deal of time for redesigning a course and its accompanying materials. Several faculty members commented on this during our interviews.

The instructor of Medical Mycology said that there is faculty inertia with respect to use of the BLC because course improvement has low priority and reward. The amount of effort put in wouldn't be considered during promotion and tenure decisions. He also mentioned that some faculty members resist the type of teaching involved in using the BLC and that there was originally some resistance to use of space for the establishment of the BLC. He did mention as encouraging a trend toward greater recognition of teaching, as indicated by the establishment of teaching awards, and the attitudes of university administrators.

The head of the Genetics Department emphasized the difficulty and slowness of educating the research-oriented faculty members about new teaching methods involving media. He believes they are concerned about use of gimmicks in education. He indicated that faculty members would more readily accept the BLC if they knew it would help them spend less time in the classroom.

The Dean of the College of Arts and Sciences, the former head of Microbiology, viewed the CAUSE project as a possible model for other divisions at the university. He indicated that media-based programs have not caught on at the university and that most science teaching is lecture and lab. The Dean said that he would like to see a mixture of traditional and audiovisual teaching methods, but that the audiovisual component should be supplementary: "They learn in lecture and in lab, and then they get extension and intensification of their learning."

The instructor of Biology 102 offered another perspective on reasons for possible slow acceptance by the BLC. He believes that the intent is remediation which detracts from making students think. He is opposed to spoon-feeding and feels that video- or audiotapes do not allow learning to come from the student. He said: "I think education is slipping. Some of the courses are too gimmicky. Students can't read, write or do math."

The chairman of the division had an interesting description of the competing commitments of faculty members. He said that in talking with faculty members about use of BLC it would be easy to interpret their comments as placing a premium on research. One might then misinterpret their comments as the nonexistence of a premium on any other activity. He said over-emphasis on research might be more acute than at some other institutions but that the university was not unique in this regard.

Evaluation. Formative and summative evaluation plans and activities on this project appear to well-considered and well-managed. Comprehensive studies of improvements in learning in a course-by-course basis have not gotten underway yet. The potential does exist for some informative studies to be carried out as illustrated by the study of interactive videotapes conducted by the instructors of Biology 105-106.

Summary

The model of change utilized by this project is one of a center of influence. That model assumes that change will occur if the experiences of faculty using the BLC are positive and productive. The project director and associate project director are well prepared to support the BLC so it will be successful. Over time it seems there has been and will continue to be additional "converts" to the BLC among the faculty. Use should increase very slowly and steadily.

There is a clear intention to continue to support the BLC and its related activities once the CAUSE project ends. In fact, it seemed that the Dean of Arts and Sciences and the division chairman had never considered that support would not continue. The actual construction and furbishing of the BLC seemed to be the biggest obstacle to having a learning center. Now that it exists, continued support is apparently assured.

Valley University

General Background

Focus:	An investigative approach to undergraduate field biology
Budget:	From NSF: $102,400 From Institution: 8,433
Began:	June, 1976
Duration:	36 months
Date of Visit:	November 15-16,1979
Visitors and Report Authors:	Terry Coleman and Esther Lee Davenport

Valley University was founded in 1890 by Scandinavian Lutheran pioneers. It occupies 130 acres in the suburbs of a medium sized industrial city and enrolls about 3,400 students, mostly full time. While the university maintains both graduate and undergraduate programs, the latter are emphasized. Many of its students are in pre-professional programs, and its science offerings are regarded as strong. A relatively recent grant to the university from a private funding agency resulted in the addition of eight research-oriented faculty in the sciences.

The historical emphasis in the Biology Department had been on descriptive biology. In the 1970's a change took place in that a balance was sought between the more traditional areas and the areas with cellular and molecular emphasis. In pursuit of this balance, it was determined that the department needed better field-oriented courses and the personnel to teach them. Consequently, several new faculty members with interests in field biology were hired.

As detailed in the Biology Department's CAUSE proposal there were several logistical problems in providing students with good field experience even though the requisite faculty had been hired. The CAUSE grant program began at about the time these problems became clear, and a decision was made to submit a CAUSE proposal. The focus of the proposal was the establishment of a permanent field station to allow students to collect on-site field data and to permit the faculty to do a better job in teaching experimental methods.

Specifically, the objectives of the project as stated in the CAUSE proposal were to:

-improve student integration of experimental aspects with theoretical aspects in the study of ecosystem structure and function;

-increase students' knowledge of and familiarity with standard sampling and analytical techniques;

-enhance student ability to participate in peer review and criticism in order to modify and construct reliable experimental techniques;

-enable undergraduate students to test the reliability and repeatability of analytical techniques by utilizing baseline and comparative data on ecosystems;

-integrate more completely regular semester, summer, and interim classes with each other and the natural setting; and

-enhance student appreciation of the interdependence of various scientific disciplines.

Information on the Site Visit

During our two days on site, we interviewed various faculty and administrative personnel including the project director, the three biology faculty members who were most actively involved in the project, two other biology faculty members who had not been very actively involved in project activities (including the present department chairperson), the division Chairperson for the Natural Sciences (also a member of the Mathematics Department), and the President of the University. In addition, we made a half day tour of the field station site, held discussions with several students using the field station, reviewed student research papers related to field site activities, and viewed several of the field site collections which were being developed.

Since we visited the site during the last year of CAUSE funding, we were interested in first of all gaining an understanding of the activities and processes which had been utilized during the primary developmental years of the project. In addition, we wanted to determine the types of problems which had been encountered, how these problems had been overcome, and what tangible outcomes of the project could be detected. Of particular interest was the way in which the field station was being integrated into the functional activities of the Biology Department in particular and the university in general.

To these ends, we felt it necessary to obtain a variety of perspectives. Those most closely associated with project activities would be most able to provide specific information about project activities, problems encountered, and identifiable or perceived outcomes. Other faculty not closely involved with the project would be able to provide a more detached viewpoint. Discussions with institutional administrators would help to ascertain the degree to which the project was meeting institutional needs and goals and was being integrated into normal institutional functioning. We felt that conversations with students, review of papers and collections emanating from field station activities, and a tour of field station facilities could be tangible indications of project outcomes.

Both site visitors arrived at the site in a very positive frame of mind, based on our reading of the project's proposal and pre-site visit planning conference. Thus, we were both probably biased to an extent with the expectation of seeing a successful project.

Description of the Project

The primary activities of the project at Valley University have been the acquisition of a permanent field study site and the construction and equipping of a field station, including a shelter, boat, and van, for use in field-oriented courses in undergraduate life sciences. Previous attempts at the university to implement investigative approaches to field biology had resulted in the identification of several major problems which the acquisition of the field station was intended to ameliorate. These problems primarily were encountered in temporary and frequent experimental setups, inadequate transportation, and lack of comparative data over time. The utilization of tents "in public campsites" as a refuge from the rainy climate limited the opportunity for immediate group discussion and analysis and the resultant physical discomfort inhibited concentration of students on scientific tasks.

While the project director has been titular head of project activities, her role has primarily been to provide budgetary coordination. She had been selected as project director because at the time of the submission of the CAUSE proposal she was chairperson of the Biology Department. Since CAUSE guidelines stressed the need for administrative involvement, it was felt to be important that an official administrator of the institution be named as project director. Her primary field of interest, however, is mammaliam physiology, and so in practice, project activities were primarily directed and coordinated by the three field biologist faculty members: a botanist, a marine biologist, and a zoologist.

From the beginning of the project, obstacles were encountered in the acquisition of the field-station site originally described in the proposal. The State Department of Natural Resources backed away from an original tentative agreement for a university/state shared site because of a more lucrative lease arrangement than the college was prepared to offer. Ultimately, the state made available a site at the edge of a not-yet-developed park about one hour travel time from the university campus, on the condition that the university would make available its data showing the impact of human use. A number of federal agencies were occupying land adjacent to the site, and negotiations with these meant delay of building activities until June 1977. During that year, however, the boat was custom-made, some equipment was acquired, and the van was purchased. Further problems in construction of the station were encountered due to the marshy nature of the site ultimately selected, and due to the distance of the site from water and electricity lines. The field station became fully usable by summer, 1979, with all utilities operable. A portion of the lab equipment named in the proposal was installed on-site and a portion was retained on campus. Considerable short-term use of the site and of the boat, however, was made even during construction.

A short distance within the grounds of a 111-acre public park soon to be opened is the field site's A-frame structure, built at the edge of deep woods. It offers shelter from bad weather and a place for analysis and discussion. A sleeping loft is upstairs. Downstairs is a roomy area with several work stations; a small refrigerator and stove; a bathroom toilet, lavatory, and shower; and a room which will house a dryer--not yet acquired since the electrical hook-up for it was accidently omitted during construction. Most of the analysis tools bought for the station are stored at the university's main campus and brought to the field station for use when needed.

Four distinct land habitats exist at the site--grasslands, deciduous forest, evergreen forest, and intertidal. Trapping grids, set by students, pepper these areas. Students set these grids of traps, mark the animals caught overnight and then release them. The traps are then reset for a second night. The proportion of previously marked animals in the second day's trapping aids in estimation of the area's population.

Another device on-site which has been used by students is a Malaise insect trap. This combination of a lure, trap, and a deadly poison can be left unattended and its contents collected at monthly intervals. The trap aids students in contrasting habitats (if the trap location is varied) as well as in observing variations in types observed at different seasons, or in different years.

The site's location on a large protected salt-water body offers a wide variety of shore/water phenomena--rocky coast, sand beach, and their associated populations. The area is also an important flyway for migratory birds; many kinds of ducks, geese, as well as many gulls and other water and land birds can be easily observed on-site.

No single individual is in charge of the field station. The three faculty most closely involved cooperate in its scheduling and use. According to reports of individuals interviewed, this arrangement to date has worked out very well and no major coordination problems have arisen. The maintenance of the station is handled from the Biology Department budget; the university administration has made a commitment to set aside a line item for this purpose in the coming year's budget. Security is in the hands of the state's parks department.

Students have been actively involved at the field site or on the boat acquired since the inception of the project. Since the summer of 1976, ten students have been involved with faculty in the collection of site baseline data and the setting of trapping grids as an out-of-class activity. Collections of the clam population have been made, insect traps have been set monthly, and many other collections have been carried out. Access to the same site has permitted continuity in data collected, thus allowing comparisons of populations over time and across the four habitats existing at the site. For example, the insect collection built by trapping at the field station has permitted students to use time and season-tagged samples to learn to classify insects by family.

Students have been involved in investigative studies of marine ecosystems. Presently, there are two distinct types of studies being carried out. One is a study of plankton; the other is a study of intertidal and subtidal communities. Initial results of these studies have resulted in a marine collection which includes samples over time of microscopic sea organisms, shellfish, other intertidal fauna, and fish samples. One of the students who has been involved in this work has invented a new type of net to catch krill which she has patented.

In addition to out-of-class projects, the field site (and boat) have been utilized in conjunction with regular course offerings in the Biology Department. Courses involved have included: Biological Oceanography, The Natural History of the Sound, Plant Taxonomy, Vertebrate Natural History, Entomology, Curating the Museum, Ornithology, Phykology. The present department chairperson who has used the field station in conjunction with one of his regularly scheduled interim semester courses stated that the one hour travel time to the field site is somewhat of a disadvantage and may prevent its regular use at other times than the interim or summer semesters.

He further stated that plans were presently in operation to utilize the field station as a workshop site for science teachers and gifted high school students.

In addition to scheduled courses, individual students have enrolled in field-oriented independent study projects. Numerous examples of student research papers exist to document the field-site related activities.

The four students whom we interviewed were very positive about the field station and their activities connected with it. Three of the students were headed for graduate school in biology, either immediately after graduation or later; one had been accepted in veterinarian school. One of these students primary research interest was in the study of enzymes in the blood of a common species of fish. His project had required the joint aid of two biology faculty members (marine biologist and bio-chemist) and a member of the Mathematics Department. Another student had used her field-site activities as the basis for a summer long job with the U. S. Fish and Wildlife Service. All four students agreed that the primary benefit of field related work was that it directly applied what they were learning in courses and taught them to "think independently . . . and take responsibility."

Issues

Institutional needs. The establishment of a permanent field station appears to have fit well with the institution's proactive effort to derive a balance between theoretical and experimental aspects of its science offerings. This effort was evidenced in faculty hiring decisions made previous to the CAUSE proposal. The geographical location of the university in a temperate climate allowed the project to capitalize on a rich biological data resource which can be accessed easily year round. Further, some evidence exists that multidisciplinary projects are underway. This, in conjunction with the increased visibility the CAUSE grant and the field station have provided to the university, enhances one of the university's major goals (as cited by the university president)--the establishment and maintenance of strong academic programs and the ability to provide students with meaningful, quality undergraduate learning experiences.

Project implementation. The primary goal of the project was the acquisition of a permanent field study site, and the construction and equipping of a field station for use in field-oriented courses in undergraduate life sciences. A field site was, indeed, acquired after a laborious series of negotiations between the university and several state and federal agencies. The boat, van, and field site shelter were acquired, constructed, and equipped. "Permanent" is a relative term, and we did not obtain much information on what protection exists for long term use of the site.

Implementation of planned project activities seemed quite successful. The project can be described as one in which implementation was mainly in the hands of those who were most deeply interested in its outcomes, one in which staffing stability was maintained in the project from proposal-writing through execution, one which met a local need (strengthening of field biology) toward which steps (hiring of faculty) had already been taken locally, and one which fit with relevant local strengths (temperate climate, varied habitats, emphasis on undergraduate education).

The unexpected problems in implementation are precisely those which still seem potential threats to the continued success of the project. The future success of the facility will require careful management. The fact that it is a private university-supported facility on state land, adjacent to several federal projects, will mean relationships with the State Parks Department and federal neighbors should be carefully maintained. The possibility for future conflicting needs for use of the site suggests that a person or committee be designated to manage (coordinate/be responsible for/ encourage use of) it. At present, no problems are apparent, but the lack of such designated responsibility seems a weakness in the integration of the project into the normal functioning of the college. Plans for physical maintenance of the facility are probably better formulated than plans for management. There were expressed intentions by both the Biology Department chairperson and the Natural Science Division chair to request a line item appropriation for maintenance of the van, boat, and shelter.

Distance to the field site was reported to us as a drawback to regular use of the site by normal semester courses. It is not clear, however, why the one hour drive should prevent one or two weekend's use of the site during any semester. This difficulty may be more perceived than real and, in fact, may suggest why an explicit managing committee or person charged to encourage as well as coordinate use is needed.

Quality of instruction. In the original CAUSE proposal, this project was envisioned to have potential to: enhance student knowledge of ecosystems; enhance student familiarity with sampling and analytical techniques; teach more effective peer review and criticism; aid integration of regular semester, summer, and interim courses; and increase student appreciation of the interdependence of biological disciplines.

Evidence we gathered during the site visit suggests that at least the first two of these goals are being realized. The comments of the students we interviewed, the quality of the papers reviewed, the number of courses which have already made use of the site, and the collections made as a result of the project all combine to suggest that these goals have a good probability of being realized. The latter three goals--of teaching peer criticism, of integrating courses, and of increasing student appreciation of interdependence in biology are not goals to which the information we gathered seems relevant.

Every category of persons interviewed--involved faculty, non-involved faculty, administration, and involved students--reported examples of positive impact on instruction. Techniques have been applied in a meaningful setting; original projects have been carried out; a student invention has resulted; faculty-student cooperation has occurred; and interdisciplinary experience has been gained. An unanticipated future outcome may be the attraction to the university of a greater proportion of students with field-oriented interests.

Evaluation. Formal evidentiary procedures to measure the effects of the project have been minimal. One study which involves a questionnaire which asks students to self-evaluate their skills at various research and scholarly activities has been implemented, but technical problems with the questionnaire itself and the overall design of the study mitigate to a large extent the meaningful interpretation of data. According to the project director, evaluation has been perceived as an activity at which academicians are not trained and at which outside assistance would have been appreciated.

Summary

The CAUSE project at Valley University is an example of a successfully implemented effort to meet specifically identified science education needs with some immediately identifiable concrete outcomes. Future success and long term institutionalization of the project will undoubtedly require additional attention to management and coordination alternatives.

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